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THESIS

**RE-ENGINEERING OF A MISSION CRITICAL
SATELLITE COMMUNICATIONS COMPONENT
TD-1271B/U**

by

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**RE-ENGINEERING OF A MISSION CRITICAL SATELLITE
COMMUNICATIONS COMPONENT TD1271B/U**

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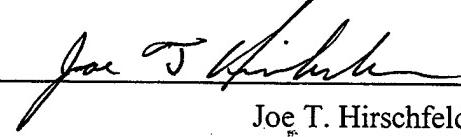
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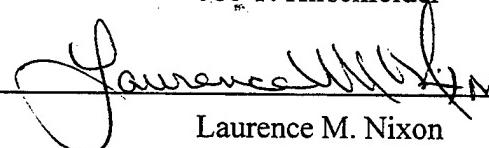
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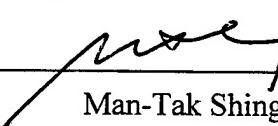
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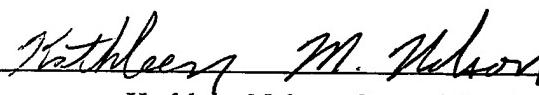


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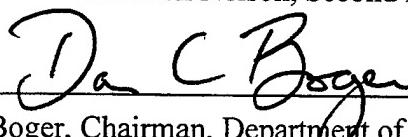
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We review existing research, select a re-engineering methodology, develop an implementation strategy and then perform a ‘case study’ examination of this methodology and strategy. For the case study, we take a legacy system, the Navy satellite communications multiplexer, the TD1271B/U Multiplexer, examine its existing documentation, develop a code analysis tool, perform the re-engineering on one of its sub-systems, and analyze the results. We provide observations, recommendations and conclusions on changes, enhancements and pitfalls to the methodology that will be of assistance in future re-engineering efforts of legacy systems.

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I. INTRODUCTION

A. BACKGROUND

One of the more complex issues associated with a software organization of significant size is the existence of large amounts of legacy software. This software typically was developed years ago, modified extensively by a variety of programmers, and is currently operating on obsolete systems hardware. The programmers that worked on the various modifications have moved on to new projects or left the organization entirely. In most instances, limited or no documentation updates have occurred. These factors all build upon each other until the software is no longer supportable. The hardware is typically old and all of the original processor reserve has been consumed, making the hardware as unsupportable as the legacy software that runs on it. The overall system is so bad that it has but one single saving grace. It works.

The program manager is charged with the responsibility of continuing to provide the services of the program while watching his ability to support the program fading. This leaves the program manager few options.

One option is to live with the system as it exists and continue to 'Band-Aid' any problems as best one can. This tends to be an expedient answer early in the life of the program, but sooner or later, this will no longer be a viable option. At some point in time the program manager will not be able to continue to support this legacy code due to physical constraints or expense.

A second option is to completely replace the existing system. This involves reviewing the current program requirements and documentation, as well as the organization operations and goals, and then to factor in those enhancements that may have forced this change in the first place. Based upon this review, a new set of requirements are generated. From these new program requirements, the program manager will need to select hardware, programming language(s), design architecture, and finally implement the software. This is then followed by a training curve to allow the operator to learn the new system. This approach has several drawbacks. The first is

usually a lack of current documentation to start the review from. It is commonplace for organizations to try to limit their maintenance costs at the expense of the quality documentation updates. Another problem are the 'hidden' enhancements; functions that are routinely used by operators, but are not documented as requirements or options even in well maintained documentation. A third is the amount of time needed to implement a full development. And, of course, there is the cost. Often for large systems the costs of a full development run hundreds of thousands of dollars, and it is not unknown for a single program's development to cost millions of dollars.

A third option is to scrap everything except for the working code and perform an in-depth analysis on the code to extract the requirements. This will tell the analyst what the code is actually doing. To this must be added the additional requirements not currently implemented. The state of the legacy code can be a drawback to this method. The success of this method is dependent upon the standards and practices used while maintaining the code. If the code was maintained by a series of programmers, each with their own standards and practices, the analyst may find extracting the information to be quite a challenge and extremely time consuming.

The fourth option is a combination of the last two, extracting the best features of each of the two options to limit the cost and time associated with updating the system. This is implemented by performing a code review and using the existing documentation as a guide to the software's basic architecture. This combination of methods reduces the amount of time required to perform the code analysis, while providing a quality requirements trace.

Each of these options has its own advantages and drawbacks. Early in the life cycle of a software system it is fairly inexpensive to correct and fix an immediate problem. As more changes are made it becomes more expensive to correct defects or make changes. It is estimated that in a large data processing shop, 70 to 80 percent of the budget is consumed by maintenance of legacy programs [40]. Eventually the legacy system will need to be modernized.

When planning the modernization of a computerized information processing system, there are two basic items to consider: the hardware and the software that comprise the system. In the normal course of events finding a new target platform is the easier process. The speed, power, and memory capacities of computer hardware have been increasing; while hardware size and costs have been steadily falling. Replacing the software itself is another question. As the costs of hardware have fallen, the costs of software development have been rising.

This contrast of costs, cheap hardware and expensive software development, leads the program manager to look at ways of lowering the cost of the software while updating the hardware platform. The first approach would be to take the working software and port it to a new, more powerful platform. This can be done in limited circumstances, but he will normally be restricted to remaining within the existing family of processors (i.e. going from a Motorola 68030 to a Motorola 68040). In the general case, he will run into the problem of incompatibility. The existing legacy software will not run on the processor in the new platform. This places the program manager at the crossroads noted above: which of the four options is best for the project?

In this thesis we will examine the ‘option four’ method of modernization, that of utilizing both the existing code and documentation to develop a new baseline program hosted on a more modern hardware platform; the process of Re-Engineering.

B. RE-ENGINEERING

There are several definitions for re-engineering in the literature today [41] as described in the following:

- "Software reengineering is any activity that (1) improves one's understanding of software, or (2) prepares or improves the software itself, usually of increased maintainability, reusability, or evolvability".
- "The process of modifying the internal mechanisms of a system or program the data structures of a system or program without changing its functionality."

- "The examination and alteration of a subject system to reconstitute it in a new form and subsequent implementations of that form."
- "Re-engineering changes the underlying technology of a system without affecting the overall function, while reverse engineering is the backward engineering of a system to the specification stage. ... Re-engineering ... is the first step toward reverse engineering"

As can be seen from these quotes, the terminology of the process is not clearly defined. Some believe that Re-engineering is the beginning of the Reverse Engineering process, other that Reverse Engineering is the beginning of the Re-engineering process. For our purpose within this thesis, we will look upon reverse engineering as the systematic review and analysis of existing code to establish an information base from which to re-implement the system i.e., the first step in the re-engineering process.

Even within these somewhat conflicting terms, there are levels of re-engineering. If the only requirement is to "copy" the existing system onto a new platform, it will only be necessary to extract the architecture from the existing code and documentation before you can re-implement the same architecture in a new environment. If you want to update the architecture, then you will need to extract up to the design level before re-coding can start. Depending on the level of re-design you wish to implement you will need to extract to one level higher to allow a baseline for forward engineering at the level you want to implement.

C. OUR THESIS

For our thesis we selected a re-engineering methodology from existing research that we thought had the best application to legacy systems. We then examined this methodology of re-engineering by performing a case study. We took a legacy system, examined the existing documentation, performed the re-engineering on one of its subsystems and then analyzed the results. Based on this analysis and other observations we will recommend modifications to the methodology that will assist in future re-engineering

efforts. Our legacy code for this procedure is a Navy satellite communications multiplexer: the TD1271B/U Multiplexer.

II. TD1271B/U MULTIPLEXER

A. BACKGROUND

Until the space age, the high frequency (HF) spectrum was the only means of passing messages over long distances by radio. Although other frequency spectrum radios were available, their characteristics limited their use to 'line-of-sight' operations or limited data rates. With the space age came the ability to place an Ultra High Frequency (UHF) radio repeater in a geosynchronous orbit. By placing a transmitting station high above the earth, it's 'line-of-sight' earth coverage was greatly expanded. The characteristics of the UHF Satellite Communications lended itself well to the needs of the Navy. It provided dependable over-the-horizon communications capability at accelerated data rates. The high data rates allow the transfer of data and voice. As the capabilities became more developed and terminals became more prolific, time lags and data delays became more regular. System throughput began to suffer. This left the Navy with a limited number of options. One was to reduce the number of users and the amount of data they were sending. This was an extremely unpopular option to the Fleet. They had grown to depend on the types and levels of data being supplied, and their effectiveness would suffer if any of the data were discontinued. The second option was to acquire more UHF channels. This was not a viable option either. The commercial world was rapidly expanding into the UHF spectrum, and lobbying congress to decrease the number of channels reserved for military use and sell them to commercial interests. The only option left was to find ways to utilize the existing channels more efficiently. To meet the need for more efficient usage of the UHF channels the Navy developed the TD-1271B/U Multiplexer.

The basic philosophy behind the TD1271B/U Multiplexer, or MUX, is to use Timed Division Multiple Access (TDMA) principals to integrated multiple nets, each operating on an independent channel, onto a single channel. By multiplexing several channels onto a single channel more data transmission path options become available.

B. TIME DEVISION MULTIPLE ACCESS (TDMA)

In TDMA, data streams at moderate to slow data rates are input via baseband data ports and buffered. At a point in time, predefined for each data port relative to a time marker, this data is transmitted out at a data rate that is significantly faster than the input data rates. While one baseband port's data is being burst out to the satellite, the other ports data streams are being buffered, awaiting their burst opportunity. Using appropriate bursting speeds, none of the baseband units will suffer any loss of continuity in their data. Each will transmit and receive data just as if on a dedicated channel, without realizing the data was multiplexed. This concept is illustrated in Figure 2-1. The key to this process is being able to transmit at a faster data rate than all of the baseband ports data rates combined. The elapse time between the start of one timing mark and the beginning of the next timing mark is generally referred to as a frame. The period of time allocated for a transmission burst is often referred to as a time slot. Depending on the particular protocol for the system, the TDMA Frame may contain a series of time slots with equal time periods or may have time slots with varying time periods.

C. TD1271B/U MULTIPLEXER

In the TD1271B/U Multiplexer (MUX) operating in the TDMA-1 25 kHz mode, a frame is defined as a period of time equaling 1.38666 seconds.¹ This frame not only has varying time slot periods, but is re-configurable based on users needs. The allocation of time slots is determined by the definition of a three digit (hex) Frame Format code. Each of the digits defines the configuration of one of the three user segments contained in the frame. A typical MUX frame is diagrammed in Figure 2-2.

The MUX waveform accommodates multiple input/output (I/O) bit rates and radio frequency (RF) symbol burst rates, as well as dynamic assignment of users between channels. Operation of the MUX waveform is transparent to the user baseband equipment, except for TDMA frame-time delays.

¹ The TD1271 MUX is also capable of a secondary waveform (TDMA-2 or TDMA-3) that utilizes a 5kHz channel. Discussion of this 5 kHz waveform is beyond the scope of this thesis.

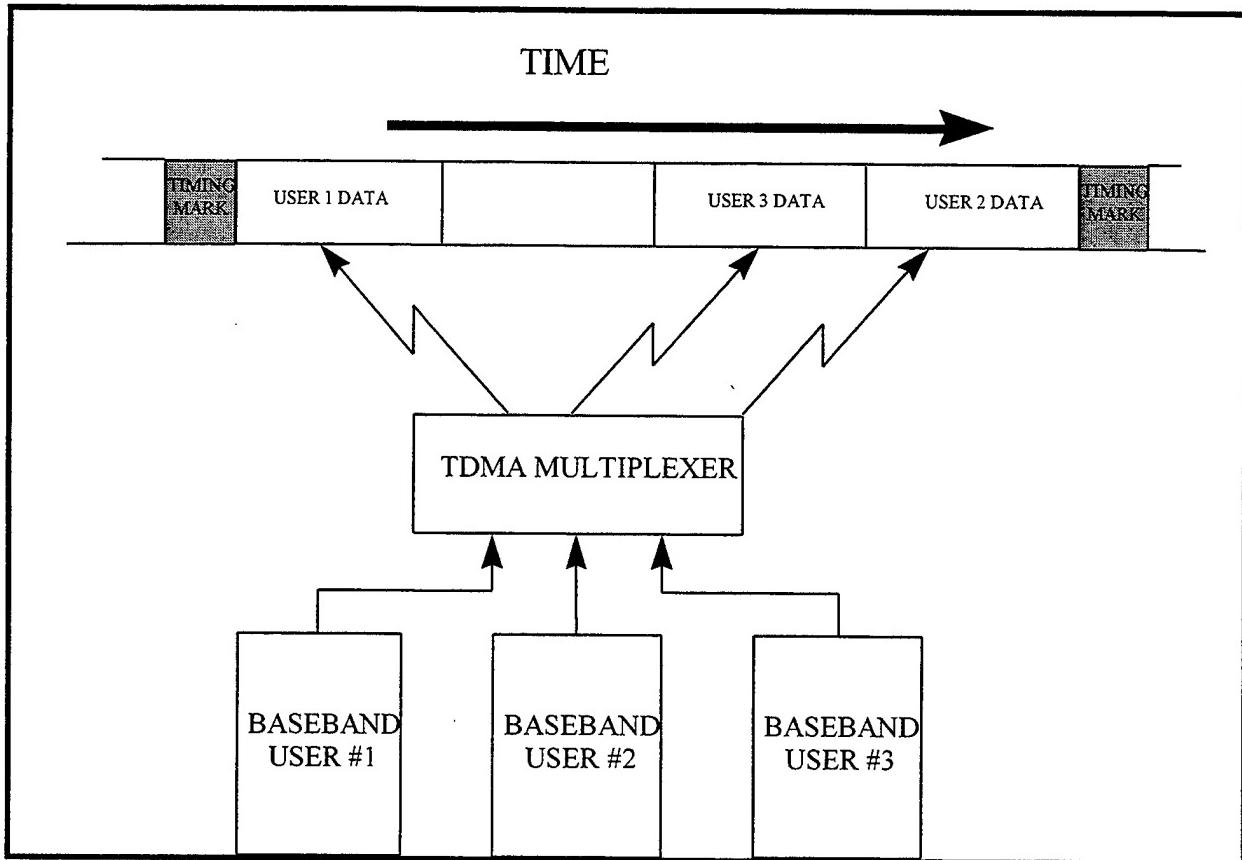


Figure 2-1
Time Division Multiplexing

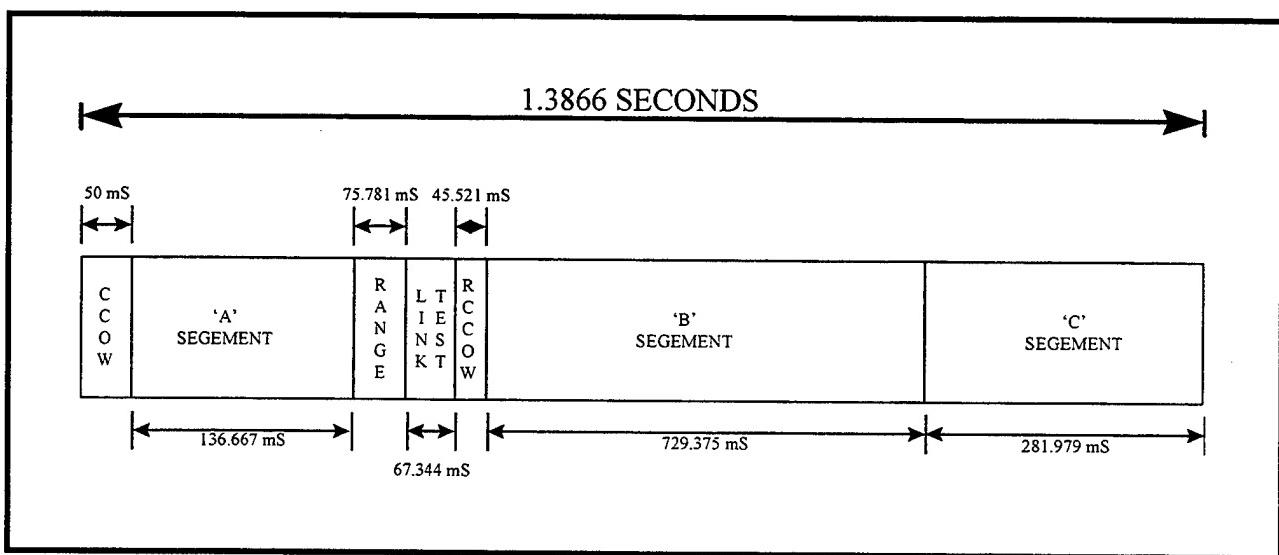


Figure 2-2
Typical TD1271B/U Frame Configuration

The MUX waveform is organized as a repetitive frame structure with 1.386-second frames, as depicted in Figure 2-2 (Frame Type 2 is depicted²). Frames are subdivided into slots assigned for: (a) orderwire communications [channel control orderwire (CCOW) and return channel control orderwire (RCCOW)]; (b) system support functions (range time slot and link-test time slot); and (c) user segments A, B, and C. User segments A, B, and C comprise multiple user slots. Each of the 5 slot types in the MUX waveform is identified below:

1. CCOW slot. The CCOW slot is used by the channel controller to broadcast CCOWs. One of the 20 defined CCOWs is transmitted by the Channel Controller in each frame. The CCOW contains the information required to control operation of the waveform and provides a timing mark for the frame.
2. RCCOW slot. The RCCOW slot provides users the opportunity to send data, including requests for access, to the channel controller.
3. Range slot. The range slot provides time for users (including the channel controller) to transmit and receive a data burst for the purpose of calculating the range to the satellite, based on measured round-trip delay time.
4. Link test slot. The link test slot provides time for users (including the channel controller) to transmit and receive a test data stream to determine the current operating conditions, based on the measured bit error ratio (BER). The link test slot is also used to perform dedicated range measurements, when the link test slot is in an even-numbered receive frame. This is known as an even link test (ELT) slot.

² In order to support half duplex terminals, the MUX waveform supports a Frame Type 1 that moves the ‘C’ segment slots between two halves of the ‘B’ segment. The half duplex network would transmit in the first ‘B’ segment and receive in the second ‘B’ segment.

5. User slot. User slots are allocated for transferring data between users. Associated with each user slot is a specific baseband data rate, encoding schema, and burst rate.

Each slot within the MUX waveform consists of three elements: (1) a preamble for receiver carrier, bit, and data synchronization; (2) data; and (3) guard time to avoid user-to-user interference. The receiving equipment achieves carrier and bit synchronization for each slot in the waveform.

The MUX waveform is designed to operate on 25-kHz non-processed channels of current and planned UHF SATCOM satellites.

The MUX accepts input from digital communications systems via it's four baseband data ports. The baseband data ports will accept data at rates of 75, 300, 600, 1200, 2400, 4800, and 16000 bits per second. In order to maintain data integrity, Forward Error Correction (FEC) encoding is used. This FEC coding is convolutional, with interleaving. Encoding rates of $\frac{1}{2}$ or $\frac{3}{4}$ are used. The MUX will output the data to the radio for transmission at one of three burst rates; 9,600, 19,200 or 32,000 symbols per second. The interface between the radios and the MUX is over 70 MHz intermediate frequency carrier lines. Reception of data is processed in a similar, but reversed, fashion.

One of the most critical functions of the MUX in this process is to maintain consistent timing within the frame. This timing begins with the reception of the timing mark to begin the frame. In the MUX system, all timing is based on the reception of the Channel Control OrderWire (CCOW). The primary CCOW is the Master Frame CCOW and contains the current frame format number, frame sequence number, and cryptographic data needed to define operations on this channel. The Master Frame is transmitted every eight frames. Other CCOWs are available to direct net operations, request data from the various terminals³ operating on the net and maintain timing.

³ Although we are only concerned with software and hardware of the TD1271B/U, there are other terminals that are operating on nets with the TD1271B/U. When discussing operations in general, we will use the term terminal to include all of the possible systems operating on a channel.

CCOWs are generated and broadcast by a specifically designated terminal. Each channel will only have a single terminal generating CCOWs at a time (the Primary Channel Controller (PCC)) although other stations could be designated as alternate controllers (ACC).

Once the MUX has successfully received the CCOW, the next critical event is to calculate the terminals distance to the satellite in units of time. The standard time unit in the MUX is the ‘time chip’. There are 19,200 time chips in one second. In order for all terminals on the net to receive data in the proper locations within the frame, all transmissions are timed to be correctly placed within the frame at the satellite. In order to insure this ‘perfect’ frame at the satellite, and by extension at each receiving terminal, the distance to the satellite must be known. This is achieved first at power-up by sending a ranging burst during the designated ranging slot, and updated periodically using the Even Link Test (ELT) slots.

D. TD-1271B/U MULTIPLEXER DESIGN

The basic TD-1271B/U installation comprises a TD-1271B/U multiplexer, a KGV-11 encryption device, a radio transceiver (a Navy WSC-3 pair is typical) and from one to four baseband user devices (ANDVT, ON-143 or teletypewriters would be typical). Figure 2-3 provides a block diagram of a basic TD-1271B/U’s configuration.

The software in the MUX is divided into three Computer Software Configuration Items (CSCI); the System Control Processor (SCP), the System Timing Processor(STP) and the Data Buffer Processor (DBP).

Each CSCI has a Memory Program Unit (MPU), an interface board, and at least one 24 k byte Ultra Violet Erasable/Programmable Read Only Memory (UVEPROM) board that contains the executable program. The SCP CSCI utilizes two UVEPROM boards.

The Memory Program Unit (MPU), hosts the Central Processor Unit (CPU), a Motorola 6800, along with the System Random Access Memory.

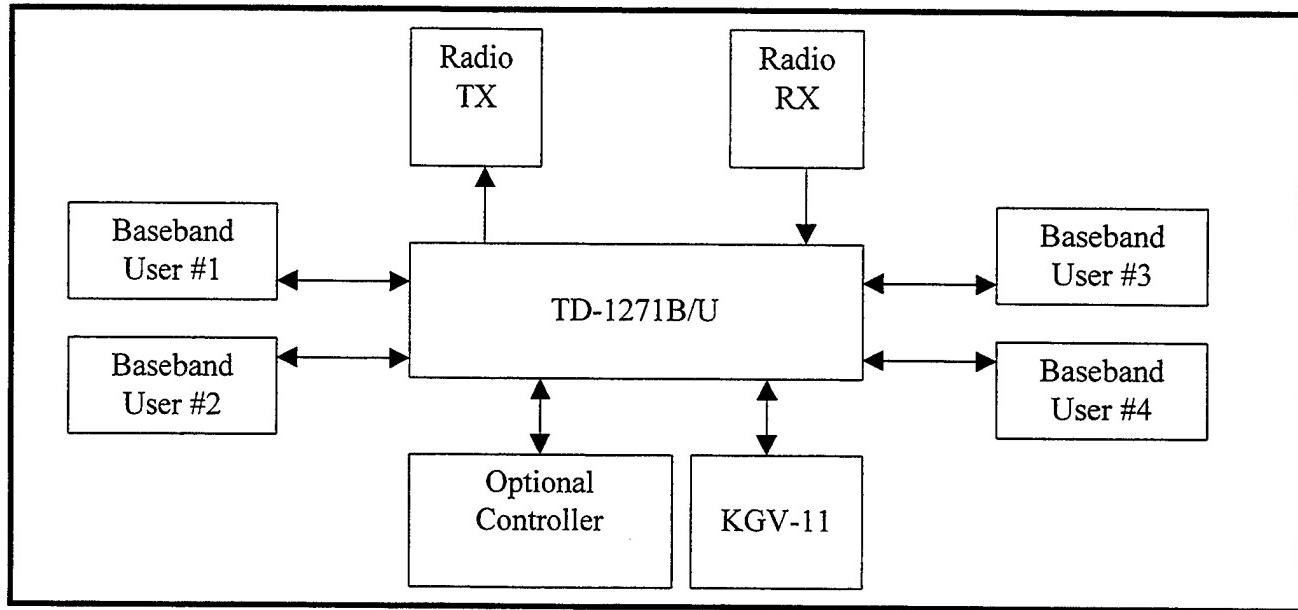


Figure 2-3
A Basic TD-1271B/U Configuration

III. THE RE-ENGINEERING PROCESS

A. PROCESS PHASES

Re-engineering begins with the assembly of all resources of a software system. This includes, but is not limited to the software source code, design documents, software development folders, test reports, software trouble reports, sample inputs, sample outputs, and, if practical, interviews of the implementers and/or maintainers. Typically the only reliable source of information is the software source code and for that reason re-engineering of an existing software system starts at the code level. The software documentation, many times, are not kept current with the software; however, it can still be a useful source of information and can be used as an engineering guide. The process in which existing software is transformed into a new implementation can be described in the Figure 3-1 [30].

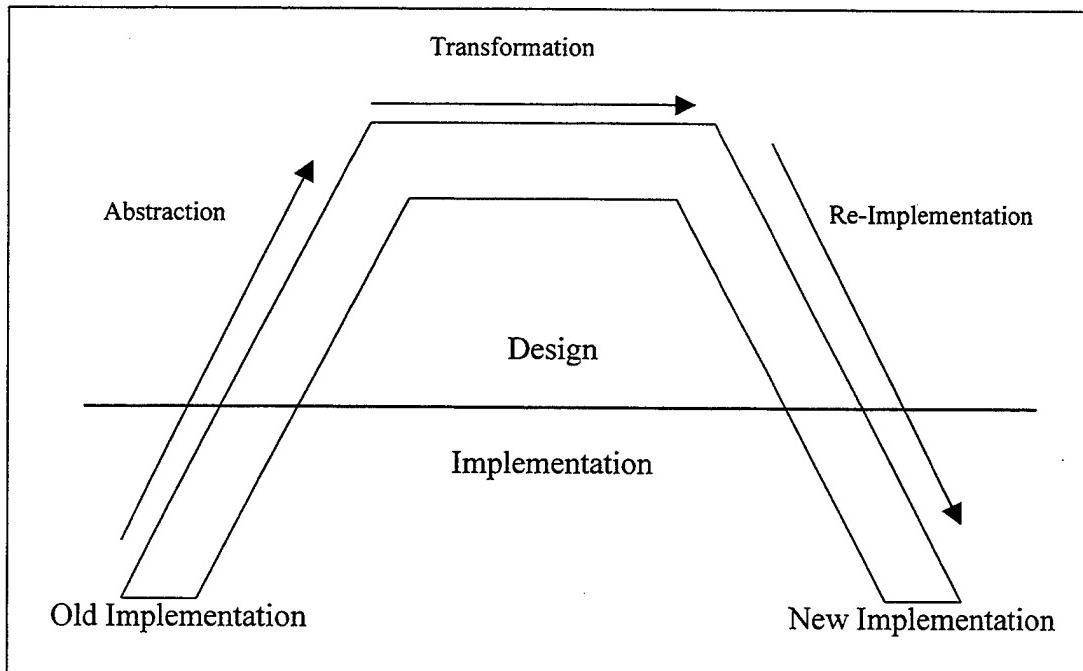


Figure 3-1
The Re-Engineering And Implementation Process

There are three phases to the re-engineering process. The first phase, abstraction, extracts the detailed design information from the documentation and the code. For those familiar with MIL-STD-498, this is analogous to creating a Software Design Document from the existing system. The second phase allows for the modification of the design by adding, deleting, or modifying requirements. The third phase is a re-implementation of the system. The focus of this thesis is the reverse engineering process that recovers the design from the old implementation. This methodology will be validated by executing the re-implementation of the recovered design using a different language and different processor than the old implementation.

1. Phase One: Abstraction

In this phase, the documentation and code can be used to provide the information needed to support the re-creation of the system design. Since the TD-1271 documentation has been shown to be unreliable, the source code will take precedence in this phase with the documentation providing background information. The products developed during abstraction are as follows [30]:

1. Structure Chart. This is a hierarchy of the modules as extracted from the program where each node in the chart corresponds to a procedure or function in the program. Since the goal of abstraction is to remove the language dependencies from the code, it is important to treat library calls as part of the system and include them in the structure chart. The language selected for the re-implementation phase may not provide the same library services. Any language dependent library calls may need to be manually re-implemented. The structure charts for this thesis are based upon the structure charts identified in reference [37]. The structure charts provide a visual representation of the software system that is useful in determining organization and dependencies. This information, once derived, is used to develop the structure charts for the enhanced system.

2. Module Description. This description is a combination of the module's inputs, processing, and outputs, with the algorithms and constraints identified. This description is produced for each module in the structure chart. In addition to a narrative of the module's processing, a language independent form using a specification language such as SPEC [42] or a Program Design Language (PDL) is used to capture the requirements of the module. For this documentation to be useful it is important to verify, through code reading, that the supporting documentation is up-to-date. A case tool that allows this information to be tagged to each element in a structure chart would be very helpful. One of the original goals was to identify a tool to preserve this information as part of this thesis, but due to budgetary considerations no tool was procured.

3. Data Flow Diagram. At a module level the data flow diagram shows the flow of data between the modules. Within the module that the data flow diagram is decomposed, showing at each successive decomposition level the transformations that occur. This information is also used to develop the algorithms that need to be documented when the design is re-implemented. These algorithms can be described using mathematical notation, a Program Design Language, or other notation. These algorithm descriptions are added to the module description in step 2. The process consists of constructing the DFD of level $i+1$ from level i . Each level explodes the data into transforms, data repositories, and data flows [37]. Data repositories will be represented as boxes, data transforms as circles, and data flows as connecting lines between transforms and data repositories. The transforms are then used in phase 2 to develop the detailed design.

4. Control Flow Diagram. This will identify the control structure of the program between the modules. This information is used to identify the logical relationships between the modules, verses the physical relationship described in step 1. [39] will be used to create this diagram.

5. State Transition Diagram. This will identify the states and modes in which the software can reside and identify the events that cause a change in the state of the software and the processing that is to occur due to the state change, and will identify the modules active for each state. There may be more than one state transition diagram depending upon the concurrency of the system. The notation for this diagram will follow those in [39].

Once the design information has been extracted, the resulting recovered design is reviewed for consistency. Any missing items of information should be investigated and added to the recovered design [30]. While it is the goal of this first phase to extract the design and leave behind the vestiges of the language and platform, the design may still have an organizational structure that was due to the implementation language and platform. Before entering phase two, the extracted design information can be modified to refine the design for portability. For example, the TD1271B/U uses multiprocessors with serial communications between them to perform the processing required. When the system is re-engineered, it is anticipated that this system will be implemented using Ada tasking on a single microprocessor. The detailed design should be abstract enough to make this possible.

2. Phase Two

Phase one used the supporting documents and the code to extract the detailed design information. This phase attempts to link the detailed design information with the requirements through the use of a requirements traceability table. This table binds the modules with the requirements that they partially or fully implement. This table will need to support one to many and many to one. That is, one requirement may be spread out over one or more modules and many requirements may be identified with one module. Depending upon the state of the supporting documentation this can be an easy task or a major effort. Requirements are needed if the system being reengineered is also having the requirements modified as well. Once the requirements have been modified, the modules affected need to be updated. It is not unusual at this phase to add and delete

modules from phase one. This phase is identified for completeness only; this thesis will not attempt to construct a requirements traceability table.

The TD1271B/U was developed under DOD-STD-1679 and any re-engineering of the TD1271B/U would use a tailored MIL-STD-498 approach. The purpose of the re-engineering effort is to develop, using the existing resources of the project, those products necessary to pass the exit criteria of the detailed design phase and allow the system to be coded. The primary product that is developed during the detailed design phase is the Software Design Document. When looking at the data item description (DID) the following sections are used to provide the programmer with the information necessary to code the system. From the re-engineering activities performed on the TD1271B/U in the three phases described above, the following module information will be developed:

- Module Name
- Module Description
- Constraints, Limitations, or Unusual Features in the Design
- Special or Unique Algorithm Description
- Called by
- Calls
- Triggering Event (tasks only)
- Implicit Inputs
- Explicit Inputs
- Implicit Outputs
- Explicit Outputs
- Hardware Dependencies
- Sizing and Timing
- Informal Test Procedures

If computer aided design tools were used during phase two, such as the Computer-Aided Prototype System (CAPS), much of the information needed for the SDD is contained within the various reports that the tools produce.

3. Phase Three

At the completion of phase two the design of the current system has been extracted. Before starting the re-implementation of the system for the new target language and hardware, any changes to the design is done in this phase. This could be a re-organization to take advantage of any special capabilities of the compiler or hardware. In addition, this would be the time to modify the requirements of the system and fold those changes into the design. Upon completion of this phase the design should reflect the system as wanted by the customer.

4. Phase Four

The output of phase three is used in this phase. This is the coding of the extracted and possibly modified design. The detail design is re-implemented using the desired methodology (i.e. OOD, structured design, etc.) in the desired language for the desired target platform. This phase is executed in the same manner as any new development.

IV. THE CASE STUDY

A. THE TD1271B/U MULTIPLEXER DATA BUFFERING PROCESSOR

The Data Buffer Processor (DBP) provides the elastic buffering required to pass continuous data between the Systems Control Processor (SCP) and I/O ports while transmitting or receiving data in bursts over the satellite channel. The heart of the DBP consists of 24K bytes of EPROM containing the software program. The program is a loop structure which sequentially scans internal control points and the baseband users to determine the actions required. If, for example, a user terminal has entered a transmit request at the baseband I/O port, a check is made of the port requirements, the port is configured to receive data and the transmit acknowledge is sent to the baseband device[43]. Figure 4-1 provides a block diagram of the relevant input and output signals to the DBP.⁴

B. DBP INPUT/OUTPUT SIGNALS

The DBP[49] data flow is described in Figure 4-1. Figure 4-1 is a description of data and control signals that are input to or output from the DBP[49].

C. THE RE-ENGINEERING STRATEGY

One of the primary goals of this re-engineering effort was an attempt to use the existing source code to extract the design of the system and to produce well designed, portable code. Ada was used as the target language during the extraction process. Since this software was originally written before the advent of structured design, we didn't attempt to use an Object-Oriented Design approach, but used a structured design approach.

⁴ This listing is not complete for the TD1271. Certain hardware control lines are system dependent and would not be applicable to this re-engineering effort.

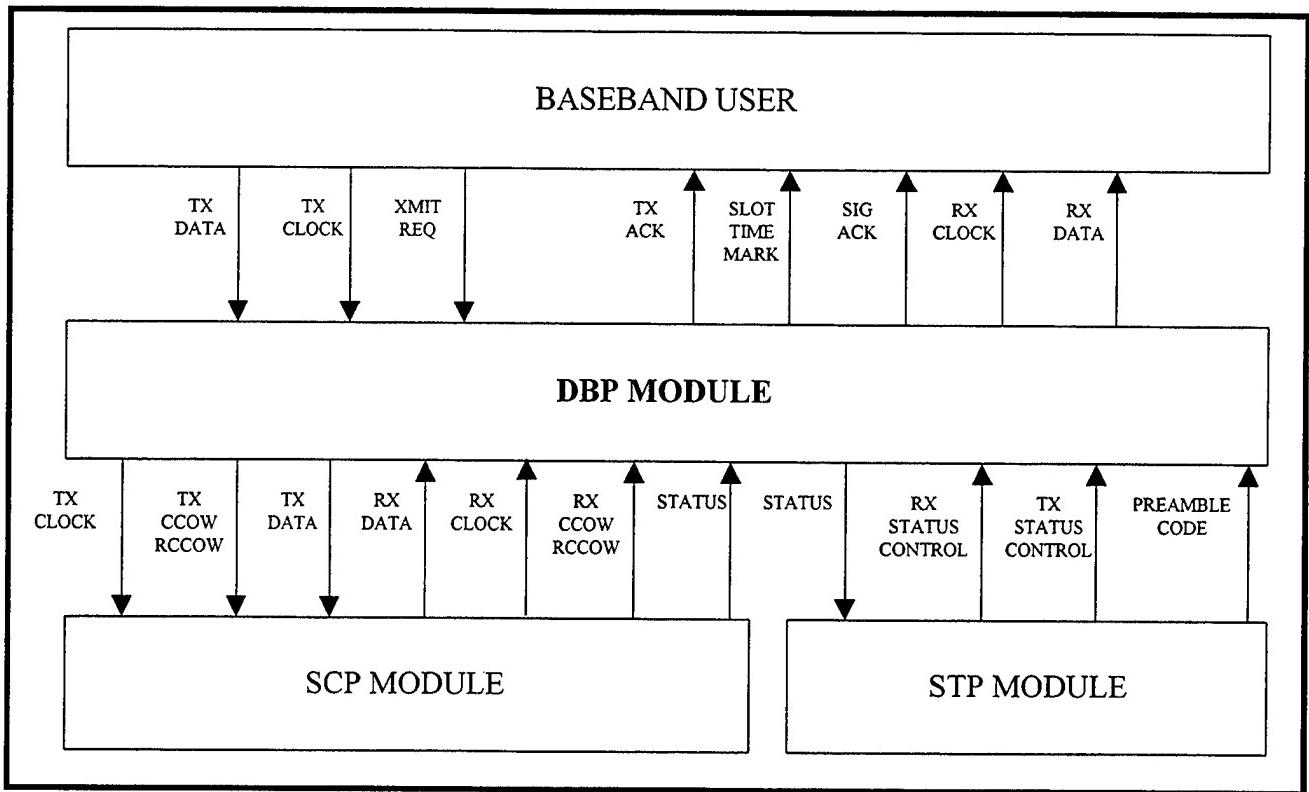


Figure 4-1
Inputs and Outputs To DBP Module

As outlined in Chapter 3, the first phase of the re-engineering effort is to develop Structural Diagrams, Module Descriptions, Data Flow Diagrams, Control Flow Diagrams, and State Transition Diagrams. The code was used to extract the structure, control flow, and state transition diagrams. The documentation was used to develop the module descriptions, provide a high level data-flow diagram and to verify the control flow and state transition diagrams whenever possible.

1. Code review

As noted by T. Bigerstaff [10], a key objective of design recovery is to develop structures that will enable a software engineer to understand the program. Our first step in this process was to identify and partition the code into procedures. This proved to be a task of greater difficulty than we had anticipated. Not only were we dealing with a

somewhat cryptic language, we were also faced with a coding style that extensively utilized ‘jump’ and ‘branch’ commands to navigate from one set of instructions to another. This programming style was intended to reduce the total size of the code by reusing existing code rather than re-writing it. Programmers coding during this period of time were highly praised if they could reduce the length of the overall program by even a few bytes, regardless of the long term maintenance problems created.

2. Extracting the Structure

The first step was to extract the modules from the code. Modules were defined as a section of code referenced in a Jump to Subroutine (JSR) or Branch to Subroutine (BSR). Even though it was recognized early on that this effort would focus only on part of the TD-1271 system it was important to extract the structure of the entire system to identify the areas in which the rest of the re-engineering effort would focus.

The code for the three major sub-systems were examined and mapped using a Microsoft Excel spreadsheet to record the results (see Appendix B - Subroutine Call Tree). It should be noted that this Subroutine Call Tree is not complete. The TD-1271 is not a procedural based design, that is it makes extensive use of GOTO statements for control between subroutines. The effort to extract the subroutine calls using the JSR/BSR opcodes was sufficient to identify which sub-system to apply the more rigorous code examination to. To produce the Subroutine Call Tree each file comprising the TD-1271 was opened in a word processor and a search was conducted on the words JSR and BSR. At each occurrence the subroutine containing the call and the subroutine that was being called were entered into the Subroutine Call Tree. Duplicate entries, the same subroutine call from the same subroutine, were not noted. The Subroutine Call Tree contains 1183 subroutine calls. After examining the results of this effort the Data Buffer Processor was selected for further investigation.

3. Extracting the Control Flow

In order to extract the control flow from the code it would be necessary to have some sort of cross reference available to consult. There weren't any tools available to do this so one was developed. A parser was written in Ada using an Alsys host compiler for

the IBM-PC. This parser uses two passes to build a cross reference for the labels in the source code and a source code listing with line numbers. The first pass identifies each label and the line of code where it is defined. The second pass identifies the line number of code where each reference occurs. References to labels that are not found are reported as errors. The only errors encountered were relative indexes based upon a label (e.g. LABEL1+2). The source code listing is in Appendix D and the Cross Reference Listing is in Appendix E. There will be references to line numbers in the source code from Appendix D later on.

A detailed examination of the DBP code identified the inter-subroutine control flow and a disturbing software design methodology, or to be more accurate - lack of one. As you can see by the control flow diagram, Figure 4-2, the designers used some programming practices that made it very difficult to extract the control flow. The first difficulty encountered was the use of multiple return from subroutine (RTS). Rather than having one entrance and exit from the subroutine there were multiple exits. This was further complicated by the use of GOTO statements where a JSR was used to enter a subroutine and both a RTS and a GOTO statement was used to return (IO1PT to IO1LF in Figure 4-2). There were subroutine calls where the called subroutine executed a GOTO statement to pass control, not back to the caller, but to another routine (IO1PT - IO1LS - IO2PT in Figure 4-2). There were manipulations of the return stack to short circuit the return from a subroutine call (Appendix D, line numbers 1044-1045 and 1099-1100 in IO1PT and repeated for the other three channels). There are examples in which a routine has multiple entrances and exits (Figure 4-3). The way this code was designed made it extremely difficult to convert to Ada, and impossible to meet the goal of having code that is well designed following this conversion. The result was becoming as poorly designed as the original. As stated earlier, this software was designed prior to the introduction of what is now considered modern programming standards. Design decisions were made based more upon memory usage and execution speed than having a system that was easy to maintain.

The subroutine IO1PT was examined for developing the inter-subroutine control flow. This was based upon the conditional statements within the code. This inter-

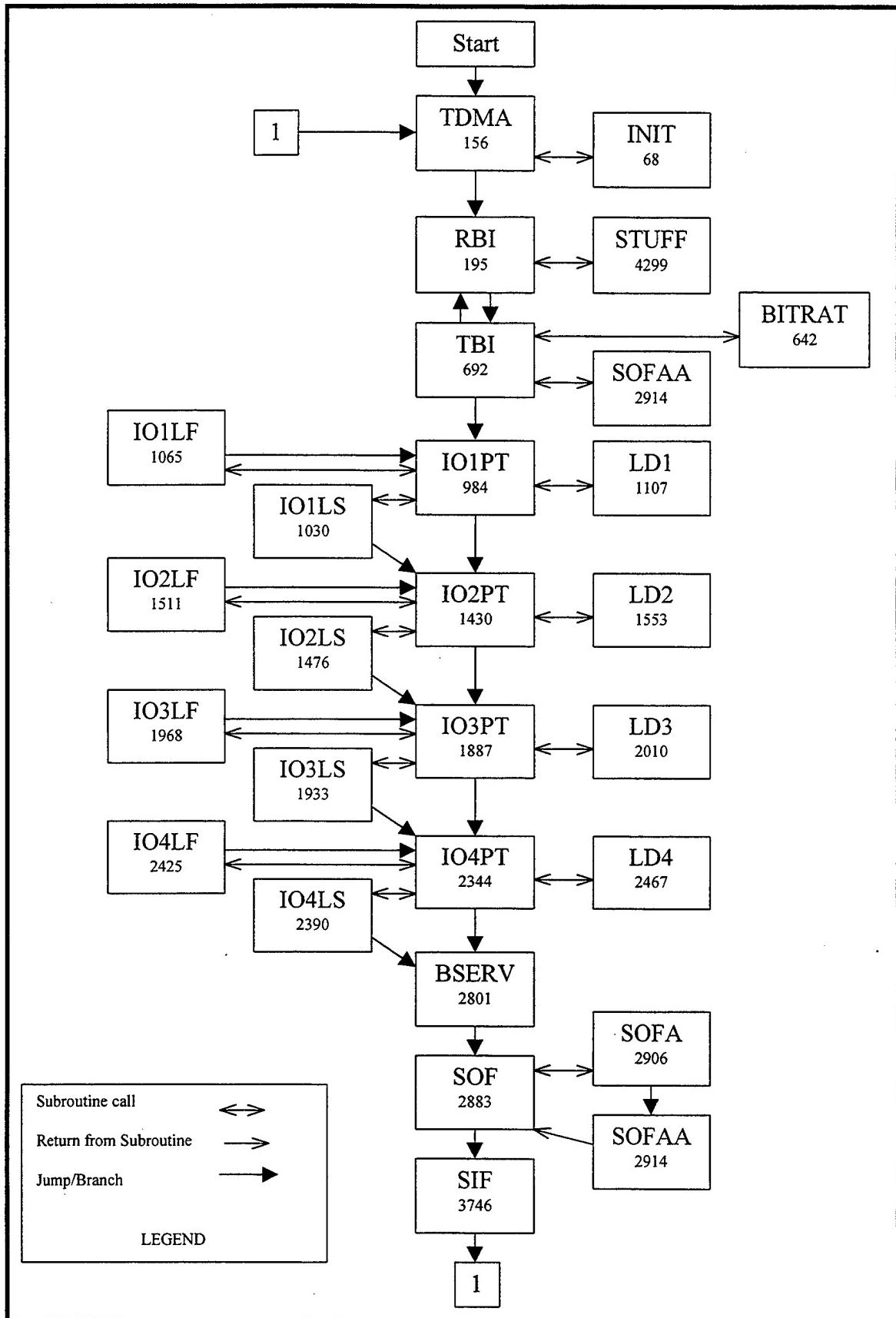


Figure 4-2
DBP Control Flow Diagram

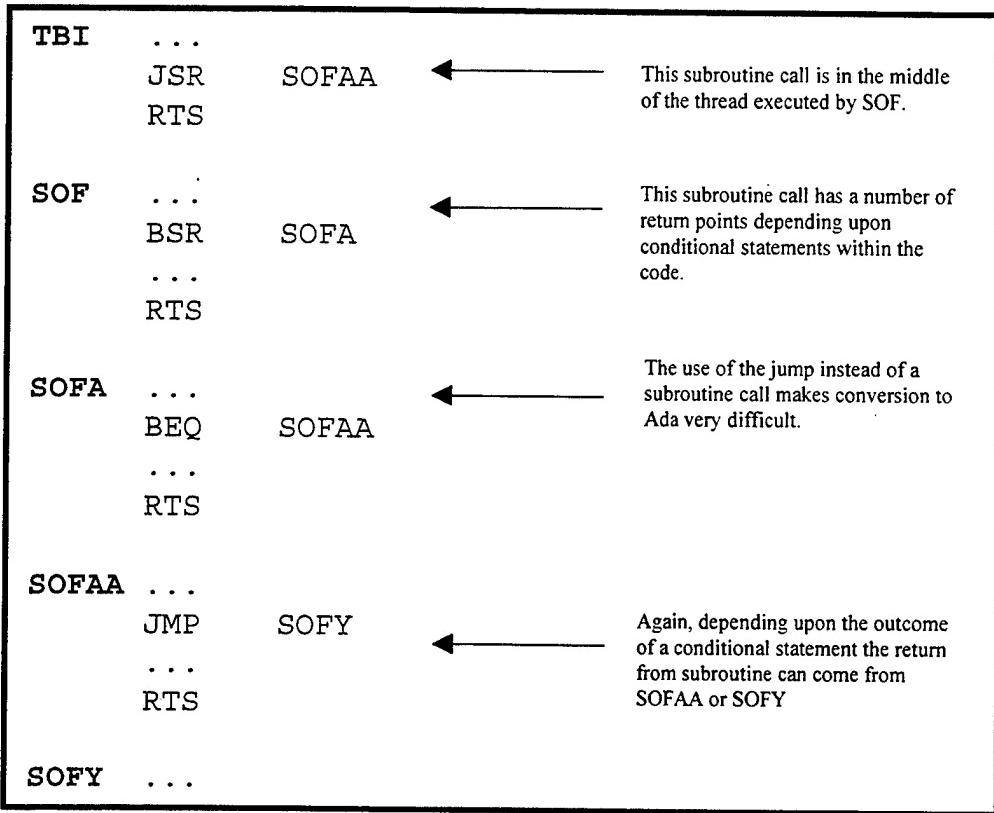


Figure 4-3
Multiple Entrances and Exits

subroutine control flow was found to be as difficult to convert as the intra-subroutine control flow. The control flow for subroutine IO1A can be visualized with Figure 4-4. As Figure 4-4 depicts, this would be an example of "spaghetti code". In order to overcome this spaghetti code problem it became necessary to reduce the code to 'mini' routines, adding 'jumps' to the end of each code fragment, so each fragment would be a stand alone routine. Each fragment could then be moved at will to try to untangle the subroutine's control flow. It too was far more difficult than it was worth. The result was a subroutine that was poorly designed.

4. Data Flow

The data was analyzed to attempt to produce a data flow diagram. The primary data flow used ringed buffers. The declared buffer started at its own starting address and ended at the starting address of the next declared buffer (e.g. an index pointer was set to

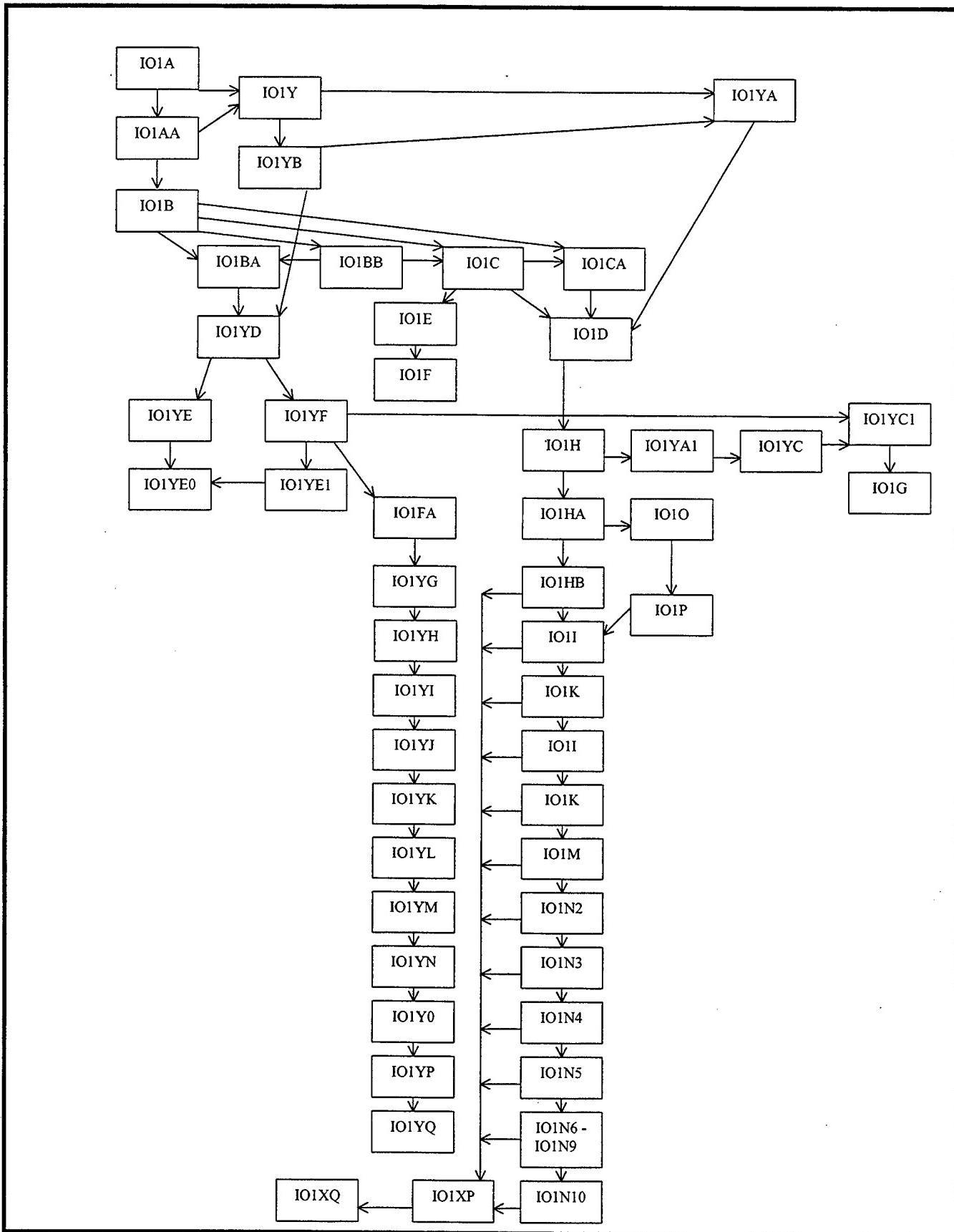


Figure 4-4
IO1A Control Flow

the starting address of a buffer and was incremented until it equaled the starting address of the next buffer). This hard coding is the easiest to overcome, but it is a glaring example of the way the software written. These ringed buffers can be easily defined using a ring buffer generic package in Ada where the data is inserted and extracted using procedure and function calls. Error handling can be included to cover the cases of underflow and overflow. The size of each buffer is then easily established during elaboration based upon the size specified. It was determined that the best source of information to establish a high level data flow diagram was the documentation. This data flow is shown in Figure 4-1. The data flow between the modules of the DBP are primarily indirect by using data stores. It was decided that the effort to describe this data flow was of little use and was not done.

D. USE OF THE TD-1271 AS AN ENGINEERING GUIDE

It was during the effort to establish the control and data flow diagrams that the determination was made that the TD-1271 should be redesigned from the top down. The source code as designed didn't support the re-engineering effort except as an engineering guide during the redesign processes.

The interrupt handlers can be used to establish the tasks responsible for the input and output of data to the DBP subsystem. While the modules are not suitable for re-engineering, the organization of the main modules can be useful in partitioning the new system. You can see by Figure 4-2 that there are four channels that are serviced in a round robin method. The new system can also use this organization. The most valuable asset the current TD-1271 has is by providing a system that works. A comparison between the behavior of the system to various inputs and what is specified in the documentation can give a good indication on the state of the documentation. It provides a strong baseline between stimulus and response that can assist in the formation of the new design.

E. DOCUMENTATION REVIEW

As was noted in the previous section, attempts to extract the requirements directly from the code became a prohibitively tedious and difficult task. This left only the

original documentation with which to attempt to baseline the requirements. The primary documentation available for the Data Buffer Processor program includes the Program Performance Specification (PPS) [49], the Program Design Specification (PDS) [50]. Also available are the system level PPS [46] and PDS [47] for the TD1271B/U. The factors and problems noted about documentation in Chapter I are evident in the TD1271B/U's documentation, and bring it's overall accuracy into question. The documents do however provide the basic requirements as they were known as late as 1987. It is these requirements that we shall briefly examine within this section relative to the re-engineering plan detailed in Chapter III.

1. Phase One: Architecture Definition.

a. *Structure Chart*

The DBP PDS [50, page 3-1] provides a basic structure chart. This is reproduced here as Figure 4-5. This structure chart does not include the modules for initialization and setup.

b. *Module Description*

Module descriptions for the six 'run time' modules are provided in both the PPS and in the PDS for the DBP. Setup and initialization are not specifically listed. Briefly these six modules are:

1. **Receive Burst Initialization Module (RBI)**. This function processes the receive burst notification from the System Timing Processor. It initializes the DBP's hardware, the I/O ports flags and pointers, and the Service Receive Burst FIFO function.
2. **Transmit Burst Initialization Module (TBI)**. This function processes the receive burst notification from the System Timing Processor. It initializes the DBP's hardware, the I/O ports flags and pointers, and the Service Transmit Burst FIFO function.

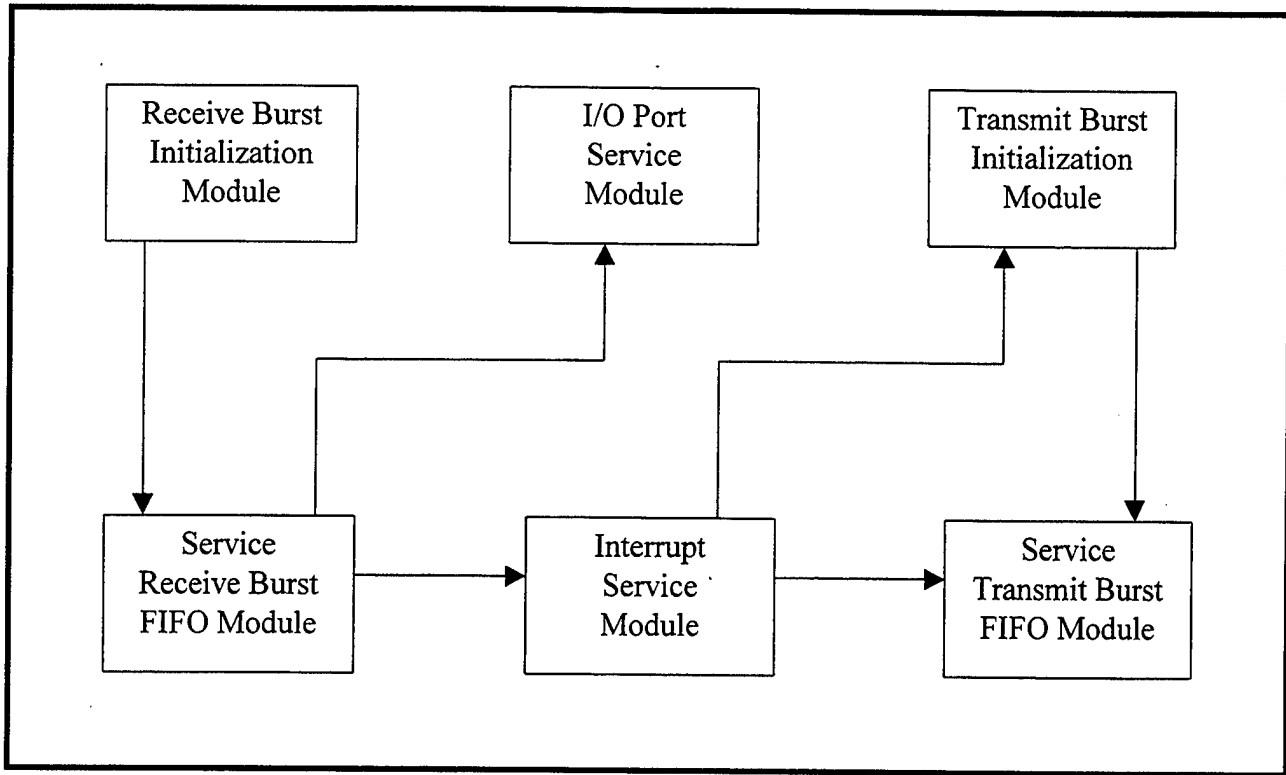


Figure 4-5
DBP High Level Structure Chart

3. I/O Port Service Module (IO1PT-IO4PT). These four modules services each of the four baseband ports. If the I/O Transmit Request input is true, the DBP will accept I/O port data and store it in the port's data buffer. If the I/O Transmit Request input is false and there is receive burst data for the port, then the I/O port service will output this data from the data buffer to the baseband equipment.
4. Service Receive Burst FIFO Module (SIF). This module inputs receive burst channel data and stores it in the data buffer.
5. Service Transmit Burst FIFO Module (SOF). This module outputs the I/O port's transmit data from the data buffer to the burst channel.
6. Interrupt Service Module (IRS). This module communicates with the System Control Processor. It receives I/O port bit rate and connection status, and it receives/transfers orderwire messages on an interrupt basis [49].

c. Data flow

The Data Flow is somewhat more difficult to extract from the documentation. By definition in the DOD-STD-1679A [51], the full definition of data variables would be documented either in the Program Design Document or in the Database Design Document. To date we have not found any reference to either of these documents. It is our belief that they were tailored out of the documentation package for the original development. This leaves some of the inputs and outputs listed in the DBP PPS and PDS open to question as to their origin and content. Clearly this is an area where it would be necessary to track the variables through out the code to ascertain their design and functions. In addition to the program variables, there are an assortment of Key Lines, Clocks, and Interrupts that need to be processed and input. Figure 4-1 provides a block diagram of the inputs and output from the DBP module.

d. Control flow

From the DBP PDS we were able to extract the basic control flow diagram. This diagram (Figure 4.6) would provide the sequencing of tasks in the new software module. It would also provide the basis for the modules for the Data Flow diagram. In addition to this ‘basic’ control flow, there is also an Interrupt handling module capable of stopping current processing and shifting control to another module.

2. Phase Two: Requirements Definition.

The second part of the re-engineering effort is to utilize the data gathered from the first phase to develop requirements. The high level requirements can be easily extracted from the module descriptions.

- R1: Will receive burst timing from System Timing Processor.
- R2: Will initialize hardware and software flags and statuses
- R3: Will input data from the Baseband ports and store.
- R4: Will receive data from the channel and store.
- R5: Will forward input data from storage to the channel.

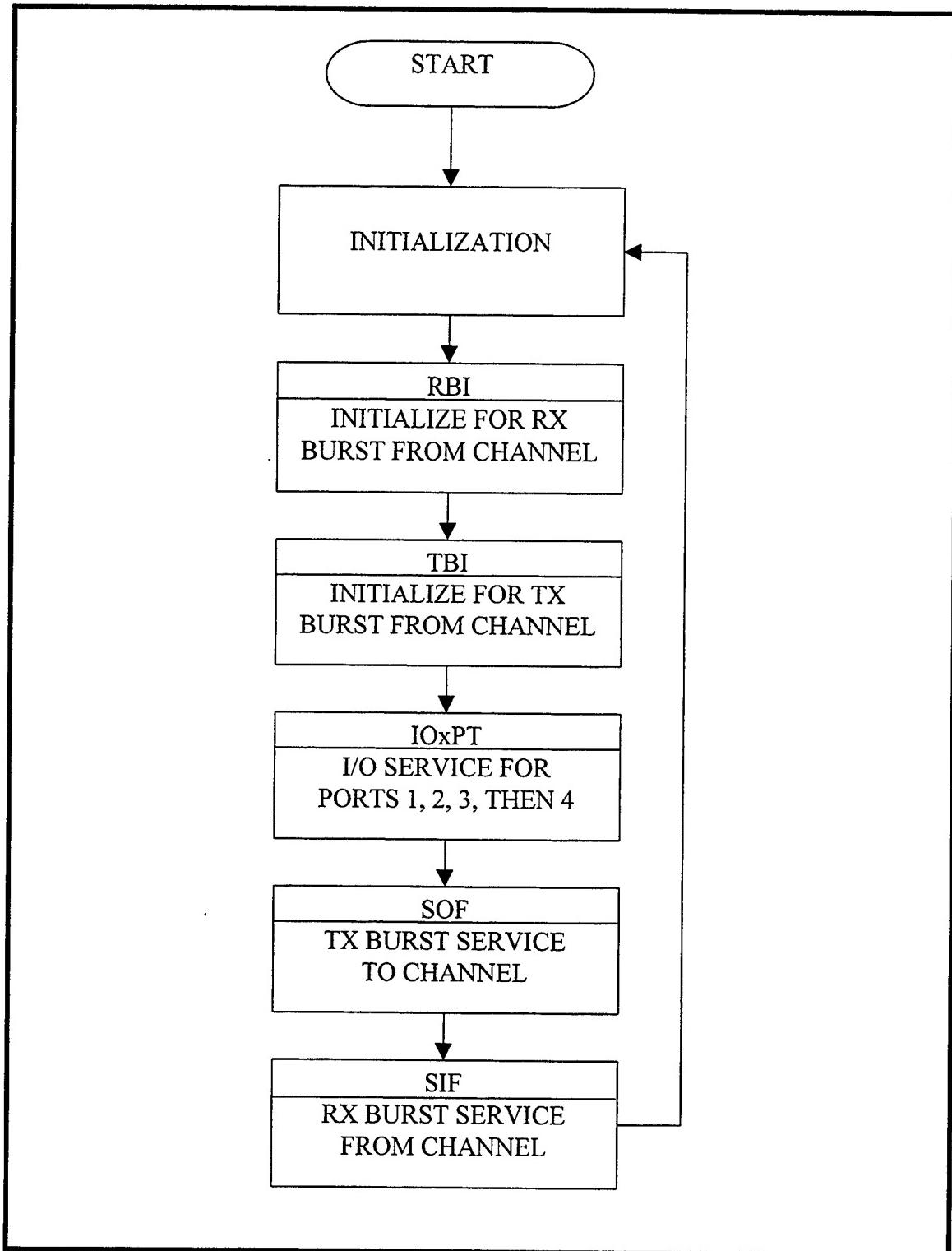


Figure 4-6
Control Flow Diagram

R6: Will output receive data from storage to the Baseband port.

R7: Will receive and transfer orderwires to and from the System Control Processor.

R8: Will receive port status and connection information from the System Control Processor.

From this point, development of more detailed requirements would progress along normal development lines. The advantage that would be gained in this area would be the ability to check the foundation of a requirement in the code. In this way the 'forward' engineering effort would have an existing system to validate the responses against.

F. RECOMMENDATIONS

Effort can be expended to convert the TD-1271 to a high order language and have it run on any number of modern day processors. To do so without reengineering the system from the top down will in effect doom this system to the same fate it has fallen to today: unstructured and not maintainable.

One of the obvious recommendations would be to use a modern programming language. Because of the use of ring buffers between the subsystems, a method that is valid in a new design, Ada would be the best choice. This would allow the use of generic packages to handle the buffers. Ada's tasking and the ability to tie the task's entry point to a hardware interrupt would be another valuable feature that makes Ada the first choice.

The original thesis called for timing studies to be conducted on the re-engineered code. Since the code never reached the state where these studies could be performed there aren't any hard numbers to address. However, the current system runs on three Motorola 6800 microprocessors. The increase in the processors throughput since the Motorola 6800 introduction would give a good indication that the entire system could fit on any number of modern day microprocessors. The hard real time requirement is handling the input from the modem. This data is transmitted at a maximum rate of 16K bits/second. Most real-time embedded applications use Wind River's VxWorks operating system. This operating system allows the application to read a serial port with a variable input size. The programmer specifies the file descriptor for the serial port, the address in

which the data is to be read, and the number of bytes to read. In addition, VxWorks provides an optimized task switch for interrupt handlers that has the overhead of a function call. Once the data has been read in the data is output as processed. By proper scaling of the input data from the modem, the processing percentage spent on handling the interrupt can be less than 10%. With these considerations our recommendation would be either the Motorola 68040 or the Motorola Power-PC.

V. CONCLUSIONS

This thesis was originally planned to be a fairly straight forward application and review of the re-engineering process. We very rapidly ran into problems of scope and time. There is a tremendous amount of data written on the subject of re-engineering. The re-engineering data not only covered software, but also included business, hardware, and other re-engineering topics. The first problem we faced was separating out the relevant topics. After 'narrowing' the scope to software re-engineering, we were still faced with a daunting amount of information to review. We found a great deal of information presented on the general theory of re-engineering, but very little concrete information on the application of these theories. We were able to locate a methodology to try [30].

The first phase of this methodology is the extraction of data from the existing code. As noted by Byrne (30), tool support for this portion is a major necessity. With appropriate tools it is possible to statically analyze and document an extensive program in a relatively short period of time. He estimates a 150 to 1 time ratio difference between manual analysis to an automated tool approach. Based on our experience, we would concur with this evaluation. We were unable to locate any tool support to automate the extraction of basic calling trees or other data from the legacy system we were looking at. Although some were found for high order languages, there were very few listings for any Assembly language, and none of these were for the Motorola 6800. This we believe will be prevalent in most legacy systems. Most of the legacy systems will be in some form of Assembly language, but there are not enough in any one language to make it commercially feasible to develop a tool to automate this portion of the re-engineering process.

When faced with poorly designed software it is important to start the re-engineering work at the lowest level in which the design is masked. For example, the preliminary design may be adequate and it was in the execution of the design that the poor design decisions were made. However, it is more likely that the designers, knowing the constraints of the environment in which they have to operate, like available memory,

will design to make optimum use of the resources available. There are examples in which the software was written with self-modifying code in order to recover memory space used for initialization as scratch pads for data. However, when re-engineering the system these type of design decisions need to be abandoned and the software needs to be designed to the standards of the times.

With the TD-1271, a tremendous amount of time was used in just trying to understand and decipher the source code. The software, with little or no comments (see Appendix D) and poorly designed control structure, cannot be recommended for re-engineering. Time and effort could be expended to re-engineer the source code: It's not an impossible task, but it is not cost effective. Nor would the result have enhanced the supportability of the software.

The only reasonable approach for the TD1271B/U would be to start at the requirements documentation, establish a testing criteria for each requirement, and perform those tests on the existing system. These tests would demonstrate if there have been modifications to each requirement that would warrant further investigation to determine the current state of that requirement. Once the modifications to the requirements have been made and a suitable target system identified, the task of re-writing the software would be considered a small to medium effort when weighed against current Navy communications systems currently under development.

APPENDIX A

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APPENDIX B

A. TD-1271B/U SUBROUTINE CALL TREE

Module Name	Located in	Is Called by	Located in
0,X		FPANEL	FP
		SRX	STPV06
		STX0	STPV06
ACK_CC_RCCOW	PRECLA	EXAM_CCOW_OVRHED	PRECLA
ADJUST_FCOUNT_GS	GS	DBP_MSG_INTRPRT	DCEEXEC
		DBP_MSG_INTRPRT	PREALT
		EXAM_CCOW_OVRHED	PRECLA
ALARM_ON_GS	GS	FPANEL	FP
		BEEP_ALARM_GS	GS
ALPHA_ONOFF_A_GS	GS	FPANEL	FP
		GLIST_DISPLY_FP	FP
		RECALL_FP	FP
		DC_HOME_FREQ_FP	FP
		AC_HOME_FREQ_FP	FP
		QUEUE_TIME_FP	FP
		CMD_RESPONSE_FP	FP
		FREQ_TO_DSPLY_FP	FP
		KG_TIME_TO_DSPLY	FP
		STATUS_RPT_B_FP	FP
		ZEROIZE_FP	FP
		CONFER_CALL_FP	FP
		INFO_REQUEST_FP	FP
		PAGING_REQ_FP	FP
		KG_MEM_CHANGE_FP	FP
		CONFIG_CODE_FP	FP
		DISP_INFO_REQ_GS	GS
		LAMP_TEST_GS	GS
		LNK_TST_RES_GS	GS
		ERR_GS	GS
		SHOW_PORT_GS	GS
ALPHA_ONOFF_B_GS	GS	FPANEL	FP
		INFO_REPORT_FP	FP
		RECALL_FP	FP
		ZEROIZE_FP	FP
		PORT_RELEASE_FP	FP
		DC_HOME_FREQ_FP	FP
		AC_HOME_FREQ_FP	FP
		SELECT_PORT_FP	FP
		PREC_ENTER_FP	FP
		KG_MEM_FILL_FP	FP
		INFO_REQ_CHK_FP	FP
		EXIT_FP	FP
		LINK_TEST_REQ_FP	FP
		CALL_COMPLETE_FP	FP
		CHAN_CONTROL_FP	FP
		OUT_OF_SERV_FP	FP
		TO_PARITY_CALL_FP	FP
		FORMAT_FREQ_FP	FP
		CONFER_CALL_FP	FP
		KG_TIME_FP	FP

Module Name	Located in	Is Called by	Located in
ALPHA_ONOFF_B_GS	GS	CALL_CANCEL_FP INFO_REQUEST_FP PAGING_REQ_FP KG_MEM_CHANGE_FP STG_CONTROL_FP CONFIG_CODE_FP LNK_TST_RES_GS CALL_CC_GS DISP_FCNT_GS	FP FP FP FP FP FP GS GS GS
AUDIO_ALARM_01	FP	FPANEL	FP
AUDIO_ALARM_02	FP	INFO_REQ_CHK_FP	FP
AUDIO_ALARM_OFF	FP	FPANEL	FP
BCD_TO_BIN_GS	GS	KG_MEM_FILL_FP INFO_REQUEST_FP YZ_TO_BIN_FP AC_HOME_FREQ_FP VWXYZ_TO_BIN_FP	FP FP FP FP
BCD_TO_YZ_FP	FP	FPANEL FREQ_TO_DSPLY_FP DC_HOME_FREQ_FP	FP FP FP
BEEP_ALARM_GS	GS	FPANEL INFO_REPORT_FP PORT_RELEASE_FP DC_HOME_FREQ_FP AC_HOME_FREQ_FP SELECT_PORT_FP PREC_ENTER_FP KG_MEM_FILL_FP CMD_RESPONSE_FP PRE_DCKA_CHK_FP CHAN_CONTROL_FP LINK_TEST_REQ_FP ZEROIZE_FP STATUS_RPT_B_FP CALL_COMPLETE_FP OUT_OF_SERV_FP TO_PARITY_CALL_FP FORMAT_PARITY_FP CONFER_CALL_FP KG_TIME_FP CALL_CANCEL_FP INFO_REQUEST_FP PAGING_REQ_FP EXTEND_XMIT_FP KG_MEM_CHANGE_FP STG_CONTROL_FP CONFIG_CODE_FP PORT_DETECT_GS LNK_TST_RES_GS ERR_GS	FP GS GS GS GS
BIN_TO_BCD_CL_GS	GS	FPANEL DC_HOME_FREQ_FP AC_HOME_FREQ_FP QUEUE_TIME_FP DISCOTIME_DISPLAY FREQ_TO_DSPLY_FP KG_TIME_TO_DSPLY	FP FP FP FP FP FP

Module Name	Located in	Is Called by	Located in
CCOW_INTP_DCMOW	DCMOW	EXEC_DCEEXEC USEREXEC	DCEEXEC DCEEXEC
CCOW_INTP_PREINT	PREINT	USEREXEC	PREALT
CHECK_A_RANGE	DCMOW/PREINT	PORT_DISCONNECT	DCMOW
CHECK_B_RANGE	PREINT	PORT_DISCONNECT	PREINT
CHECK_C_RANGE	DCMOW/PREINT	PORT_DISCONNECT	DCMOW
CHECKSUM_CHK_GS	GS	INIT_DCEEXEC INIT	DCEEXEC PREALT
CHK_FRAME_COUNT	PRECLA	FRAME_CHK_PRECLA	PRECLA
CHK_GLIST	PREINT	SLOT_DISCONNECT CALL_WAITING HOME_CHAN_CHANG SLOT_CONNECT FORMAT_CHANGE	PREINT PREINT PREINT PREINT
CLEAR	DBPV4	PWRON SETUP	DBPV4 DBPV4
CLEAR_CONT_COUNT	PREINT	BUSY_ACK CALL_IN_QUE_ACK USER_OUT_ACK CALL_ACK	PREINT PREINT PREINT PREINT
CLEAR_DISP_GS	GS	FPANEL SHOW_PORT_GS	FP GS
CLEAR_GNUM	PREINT	RPT_GLIST1 RPT_GLIST2 RPT_GLIST3 RPT_GLIST4	PREINT PREINT PREINT PREINT
CLEAR_GUARD_LIST	DCMOW	FRAME_FMT_UPDATE	DCMOW
CLEAR_LITES_TIME	PREINT	CALL_CANCEL	PREINT
CLEAR_QUE_TIME	PREINT	SLOT_CON_UPDATE	PREINT
CLEAR_SLOTS_GS	GS	RRU_CALLCAN_15 PORT_DISCONNECT CHAN_CONTROL_FP STATUS_PRECLA ZEROIZE PORT_DISCONNECT	PREINT DCMOW FP PRECLA PREINT PREINT
CLR_RRU_05	PREALT	RRU_MSG_UPDATE	DCEEXEC
CLR_RRU_PREC_DSP	DCEEXEC/PREALT	RRU_MSG_UPDATE	DCEEXEC
CLRTIM	PREINT	RRU_MSG_UPDATE BUSY_ACK USER_OUT_ACK SLOT_CON_UPDATE CALL_CANCEL PARTY_OUT_OF_SYNC	PREALT PREINT PREINT PREINT PREINT

Module Name	Located in	Is Called by	Located in
CMD_RESPONSE_FP	FP	ZEROIZE_FP INFO_REPORT_FP TO_PARITY_CALL_FP FORMAT_FREQ_FP CONFER_CALL_FP DC_HOME_FREQ_FP AC_HOME_FREQ_FP KG_TIME_FP INFO_REQUEST_FP GLIST_ENTER_FP PAGING_REQ_FP KG_MEM_CHANGE_FP GLIST_DELETE_FP STG_CONTROL_FP CONFIG_CODE_FP CHAN_CONTROL_FP	FP FP FP FP FP FP FP FP FP FP FP FP FP FP FP FP FP FP
COMMAND_FRAME	PREINT	CCOW_INTP_DCMOW CCOW_INTP_05	DCMOW PREINT
COMP_FRAME_GS	GS	FRAME_CHK_DCCNTR FRAME_CHK_PRECLA MASTER_FRAME	DCCNTR PRECLA PREINT
CONFIG_CODE_GS	GS	INFO_REQ_CHK_FP	FP
CONS	STPV06	CONFIG	STPV06
CONT_CHK_PREINT	PREINT	RCOW_PREP_XMIT CLEAR_CONT_COUNT READ_CALL_ACK	PREALT PREINT PREINT
CORRECT_ONE_BCD	GS	BCD_TO_BIN_GS	GS
CORRECT_TWO_BCD	GS	BIN_TO_BCD_GS	GS
CYCLEDITES_DCMOW	DCMOW	ZEROIZE TS_PREP INFO_REQUEST_GS	DCMOW DCMOW GS
DBP_MSG_INT_30	DCEXEC/PREALT	EXEC_PREALT	PREALT
DBP_MSG_INT_35	DCEXEC/PREALT	EXEC_DCEXEC	DCEXEC
DBP_MSG_INTRPRT	DCEXEC/PREALT	USEREXEC USERPREAC USERPREAC USEREXEC	DCEXEC DCEXEC PREALT PREALT
DCKPORTOFF_GS	GS	INFO_REQUEST_GS PORT_DETECT_GS	GS GS
DECODE_FP	FP	FPANEL KG_MEM_FILL_FP	FP FP
DECRYPT_CCOW	DCEXEC/PREALT	DBP_MSG_INTRPRT DBP_MSG_INTRPRT	DCEXEC PREALT
DECRYPT_RCOW_GS	GS	DBP_MSG_INTRPRT DBP_MSG_INTRPRT	DCEXEC PREALT
DEL_FROM_GLIST	PREINT	DELET_GUARD_LIST GLIST_ENTDEL_30	PREINT PREINT
DELAY_TOGGLE_GS	GS	STATUS_DCCNTR CC_EXEC_PRECLA RCV_CCOW_BLOCK STATUS_PRECLA	DCCNTR PRECLA PRECLA PRECLA
DID	STPV06	RNGEXC LTEXEC	STPV06 STPV06

Module Name	Located in	Is Called by	Located in
DISCO_SLOT_CHK	DCMOW/PREINT	CHECK_A_RANGE	DCMOW
		CHECK_B_RANGE	DCMOW
		CHECK_C_RANGE	DCMOW
		CHECK_A_RANGE	PREINT
		CHECK_B_RANGE	PREINT
		CHECK_C_RANGE	PREINT
DISCOTIME_DISPLAY	FP	FPANEL	FP
		RECALL_FP	FP
DISP_FCNT_GS	GS	ZEROIZE_FP	FP
		CHAN_CONTROL_FP	FP
		DC_HOME_FREQ_FP	FP
		AC_HOME_FREQ_FP	FP
		SELECT_PORT_FP	FP
		CALL_COMPLETE_FP	FP
		STATUS_RPT_B_FP	FP
		GLIST_DISPPLY_FP	FP
		LINK_TEST_REQ_FP	FP
		INFO_REPORT_FP	FP
		TO_PARITY_CALL_FP	FP
		FORMAT_FREQ_FP	FP
		CONFER_CALL_FP	FP
		KG_TIME_FP	FP
		CALL_CANCEL_FP	FP
		INFO_REQUEST_FP	FP
		GLIST_ENTER_FP	FP
		PAGING_REQ_FP	FP
		KG_MEM_CHANGE_FP	FP
		GLIST_DELETE_FP	FP
		STG_CONTROL_FP	FP
		CONFIG_CODE_FP	FP
		OUT_OF_SERV_FP	FP
		LNK_TST_RES_GS	GS
DISP_INFO_REQ_GS	GS	FPANEL	FP
DISP_VWXYZ_GS	GS	FPANEL	FP
		RECALL_FP	FP
		LNK_TST_RES_GS	GS
DISPLAY_EEEEE_GS	GS	GLIST_DISPPLY_FP	FP
		ERR_GS	GS
DISPLAY_TO_BCD_GS	GS	FORMAT_FREQ_FP	FP
		AC_HOME_FREQ_FP	FP
		VWXYZ_TO_BIN_FP	FP
		YZ_TO_BIN_FP	FP
		WX_TO_BCD_FP	FP
		YZ_TO_BCD_FP	FP
		CONFIG_CODE_FP	FP
ENCRYPT_CCOW	DCEEXEC/PREALT	EXEC_DCEEXEC	DCEEXEC
		EXEC_PRACT	PREALT
ENCRYPT_RCOW_GS	PREALT	RCOW_PREP_XMIT	DCEEXEC
		RCOW_PREP_XMIT	PREALT
EQUIPED_REDO	FP	FPANEL	FP

Module Name	Located in	Is Called by	Located in
FIXA_GS	GS	FPANEL	FP
		CONFER_CALL_FP	FP
		QUEUE_TIME_FP	FP
		DISCOTIME_DISPLAY	FP
		KG_MEM_FILL_FP	FP
		FREQ_TO_DSPLY_FP	FP
		PAGING_REQ_FP	FP
		KG_MEM_CHANGE_FP	FP
		LINK_TEST_REQ_FP	FP
		FIXAB_GS	GS
FIXAB_GS	GS	FPANEL	FP
		SHOW_YZ_GS	GS
		SHOW_WX_GS	GS
FIXB_GS	GS	FIXA_GS	GS
		QUEUE_TIME_FP	FP
		DISCOTIME_DISPLAY	FP
		CMD_RESPONSE_FP	FP
		FREQ_TO_DSPLY_FP	FP
FMT_GLIST_RCW_05	PREINT	DISPLAY_TO_BCD_GS	GS
		SET_GLIST_PTR	PREINT
		SET_GLIST_PTR	PREINT
		SET_GLIST_PTR	PREINT
		CLEAR_GNUM	PREINT
		FORMAT_CHANGE	PREINT
		RPT_GLISTI	PREINT
		USEREXEC	DCEXEC
		USERPREAC	DCEXEC
		USERPREAC	PREALT
FP_PANEL_F	FP	USEREXEC	PREALT
		USEREXEC	DCEXEC
		USERPREAC	DCEXEC
		USEREXEC	PREALT
FRAME_CHK_DCCNTR	DCCNTR	USEREXEC	DCEXEC
		USERPREAC	DCEXEC
		DBP_MSG_INTRPRT	DCEXEC
FRAME_CHK_PRECLA	PRECLA	USEREXEC	PREALT
		USERPREAC	PREALT
		DBP_MSG_INTRPRT	PREALT
FRAME_FMT_UPDATE	DCMOW	MASTER_FRAME	DCMOW
FREEZE_DISPLAY	FP	FORMAT_FREQ_FP	FP
		DC_HOME_FREQ_FP	FP
		KG_TIME_FP	FP
		KG_MEM_CHANGE_FP	FP
FREQ_CODE_CHK_5	FP	KG_TIME_FP	FP
FREQ_CODE_CHK_FP	FP	FORMAT_FREQ_FP	FP
		DC_HOME_FREQ_FP	FP
FREQ_TO_DSPLY_FP	FP	FORMAT_FREQ_FP	FP
FSLOT	STPV06	SRX	STPV06
GET_RANDOM_NR_GS	GS	RCOW_PREP_XMIT	PREALT
		COMP_RRU_PREC	PREINT

Module Name	Located in	Is Called by	Located in
INFO_REPORT_FP	FP	CALL_CC_GS	GS
INFO_REQ_05_GS	GS	HOME_CHAN_05	PREINT
INFO_REQ_CHK_45	FP	SELECT_PORT_FP	FP
INFO_REQ_CHK_50	FP	PORT_RELEASE_FP	FP
INFO_REQ_CHK_FP	FP	FPANEL	FP
INIT	PREALT/DBPV4 (LABEL)	PWRON	DBPV4
		TDMA	DBPV4
INITIAL_ENTRY	PREINT	RRU_STATUS_RPTB	PREINT
		DATA_XFER	PREINT
		CALL_COMPLETE	PREINT
		RRU_PRTY_OUT_05	PREINT
		INFO_RPT_05	PREINT
		RRU_CALL_CAN_15	PREINT
		PAGING_05	PREINT
		STATUS_RPT_A	PREINT
		LINK_RESULT	PREINT
		FORMAT_GLIST_RCW	PREINT
		CALL_REQ_05	PREINT
		CONF_REQ_05	PREINT
IO1LF	DBPV4	IO1A	DBPV4
IO1LS	DBPV4	IO1A	DBPV4
IO2LF	DBPV4	IO2A	DBPV4
IO2LS	DBPV4	IO2A	DBPV4
IO3LF	DBPV4	IO3A	DBPV4
IO3LS	DBPV4	IO3A	DBPV4
IO4LF	DBPV4	IO4A	DBPV4
IO4LS	DBPV4	IO4A	DBPV4
JUMP_COMPLETE_GS	GS	DCKPORTOFF_GS	GS
JUMP_SELECT_1_GS	GS	DCKPORTOFF_GS	GS
		SHOW_PORT_GS	GS
		CALL_CC_GS	GS
JUMP_SELECT_2_GS	GS	DCKPORTOFF_GS	GS
		SHOW_PORT_GS	GS
		CALL_CC_GS	GS
KB_TIME_INIT_GS	GS	ZEROIZE_FP	FP
		OUT_OF_SERV_FP	FP
		STATUS_RPT_B_FP	FP
		GLIST_DISP_FTP	FP
		LINK_TEST_REQ_FP	FP
		INFO_REQUEST_FP	FP
		TO_PARITY_CALL_FP	FP
		CONFER_CALL_FP	FP
		CALL_CANCEL_FP	FP
		INFO_REQUEST_FP	FP
		GLIST_ENTER_FP	FP
		PAGING_REQ_FP	FP
		CONFIG_CODE_FP	FP
		CALL_COMPLETE_FP	FP
KG_INITIAL_GS	GS	EXEC_DCEXEC	DCEXEC
		EXEC_PREALT	PREALT
		ENCRYPT_CCOW	PREALT

Module Name	Located in	Is Called by	Located in
KG_INITIAL_GS_05	GS	ENCRYPT_CCOW	DCEEXEC
		DECRYPT_CCOW	DCEEXEC
		DECRYPT_RCOW_GS	GS
		ENCRYPT_RCOW_GS	GS
		ENCRYPT_CCOW	PREALT
		DECRYPT_CCOW	PREALT
KG_LOAD_GS	GS	USERPREAC	DCEEXEC
		ENCRYPT_CCOW	DCEEXEC
		USERPREAC	PREALT
KG_MEM_CHANGE_GS	GS	EXEC_DCEEXEC	DCEEXEC
		TS_PREP_DCEEXEC	DCEEXEC
		EXEC_PREALT	PREALT
		TS_PREP_PREALT	PREALT
		KG_LOAD_GS	GS
KG_MEM_FILL_20	FP	KG_MEM_FILL_FP	FP
KG_MEM_FILL_FP	FP	FPANEL	FP
KG_MEM_TEST_GS	GS	EXAM_CCOW_OVRHED	PRECLA
		KG_MEM_CHANGE_GS	GS
		KG_RESET_GS	GS
KG_READY_GS	GS	EXAM_CCOW_OVRHED	PRECLA
		KG_RESET_GS	GS
		KG_INITIAL_GS	GS
KG_RESET_GS	GS	EXEC_DCEEXEC	DCEEXEC
		TS_PREP_DCEEXEC	DCEEXEC
		ENCRYPT_CCOW	DCEEXEC
		DECRYPT_CCOW	DCEEXEC
		DECRYPT_RCOW_GS	GS
		ENCRYPT_RCOW_GS	GS
		KG_MEM_CHANGE_GS	GS
		EXEC_PREALT	PREALT
		TS_PREP_PREALT	PREALT
		ENCRYPT_CCOW	PREALT
KG_TIME_75	FP	DECRYPT_CCOW	PREALT
		KG_TIME_FP	FP
KG_TIME_TO_DSPLY	FP	KG_TIME_FP	FP
KG_ZEROIZE_GS	GS	STATUS_DCCNTR	DCCNTR
		STATUS_PRECLA	PRECLA
LD1	DBPV4	IO1A	DBPV4
LD2	DBPV4	IO2A	DBPV4
LD3	DBPV4	IO3A	DBPV4
LD4	DBPV4	IO4A	DBPV4
LITES_OFF_DCMOW	DCMOW	STATUS_DCCNTR	DCCNTR
		ZEROIZE	DCMOW
		FRAME_FMT_UPDATE	DCMOW
		CHAN_CONTROL_FP	FP
		RECALL_FP	FP
LITES_OFF_GS	GS	INFO_REQUEST_FP	FP
		PORT_RELEASE_FP	FP
		INFO_REQ_CHK_FP	FP
		CALL_COMPLETE_FP	FP
		LINK_TEST_REQ_FP	FP
		ZEROIZE_FP	FP
		STATUS_RPT_B_FP	FP
		GLIST_DISPFLY_FP	FP
		CHAN_CONTROL_FP	FP
		OUT_OF_SERV_FP	FP

Module Name	Located in	Is Called by	Located in
LITES_OFF_PREINT	PREINT	STATUS_PRECLA FORMAT_UPDATE NUFMT_TO_STP	PRECLA PREINT PREINT
LNK_TST_LAMP_GS	GS	TO_PARITY_CALL_FP FORMAT_FREQ_FP PORT_RELEASE_FP DC_HOME_FREQ_FP AC_HOME_FREQ_FP QUEUE_TIME_FP SELECT_PORT_FP CONFER_CALL_FP KG_TIME_FP CALL_CANCEL_FP INFO_REQUEST_FP GLIST_ENTER_FP PAGING_REQ_FP EXTEND_XMIT_FP KG_MEM_CHANGE_FP GLIST_DELETE_FP STG_CONTROL_FP CONFIG_CODE_FP LAMP_TEST_GS	FP FP FP FP FP FP FP FP FP FP FP FP FP FP FP FP FP FP GS
LO_GUARD_CHK_FP	FP	GLIST_ENTER_FP	FP
LOAD_KG_VARS_GS	GS	ENCRYRPT_CCOW DECRYPT_CCOW DECRYPT_RCOW_GS ENCRYPT_RCOW_GS ENCRYPT_CCOW DECRYPT_CCOW	DCEEXEC DCEEXEC GS GS PREALT PREALT
LTRXEX	STPV06	EXEC	STPV06
MASTER_FRA_05	PREINT	MASTER_FRAME	PREINT
MASTER_FRA_10	PREINT	MASTER_FRAME	PREINT
MASTER_FRAME	DCMOW/PREINT/DCCNTR	CCOW_INTP_DCMOW CCOW_INTP_PREINT	DCMOW PREINT
MOVE_FRAME_GS	GS	MASTER_FRAME FRAME_CHK_DCCNTR	DCCNTR DCCNTR
MOVE_GS	GS	SPECIAL_CCOW RCOW_INTP_DCCNTR INIT MOVE_TMP_TO_VARS MOVE_VARS_TO_TMP STP_MSG_INTRPRT MOVE_VARS_TO_TMP MOVE_TMP_TO_VARS STP_MSG_INTRPRT RCOW_INTP_PRECLA	DCCNTR DCEEXEC DCEEXEC DCEEXEC DCEEXEC PREALT PREALT PREALT PREALT PREALT
MOVE_TMP_TO_VARS	DCEEXEC/PREALT	USERPREAC USERPREAC	PREALT DCEEXEC
MOVE_VARS_TO_TMP	DCEEXEC/PREALT	USERPREAC USERPREAC	DCEEXEC PREALT
NET_NUM_XCHNG	DCEEXEC	DECRYPT_CCOW	DCEEXEC
NUFMT_TO_STP	PREINT	MASTER_FRAME FORMAT_CHANGE	PREINT PREINT
ODD_PORT_STORE	PREINT	RRU_STATUS_RPTB	PREINT

Module Name	Located in	Is Called by	Located in
OFFSET_BY_3_GS	GS	CC_EXEC_DCCNTR COMMAND_FRAME	DCCNTR DCMOW
OFFSET_BY_6_GS	GS	CC_EXEC_DCCNTR COMMAND_FRAME	DCCNTR DCMOW
OUT_SVC_UPDATE	PREINT	USER_OUT_ACK PART_OUT_OF_SVC	PREINT
PLACE_CALL_PRTY	PREINT	CONF_REQ_05	PREINT
PLACE_PORT	PREINT	CONFER_LIST_RPT STATUS_RPT_B	PREINT
POINT_TO_GLIST1	PREINT	SET_GLIST_PTR	PREINT
POINT_TO_GLIST2	PREINT	SET_GLIST_PTR	PREINT
POINT_TO_GLIST3	PREINT	SET_GLIST_PTR	PREINT
POINT_TO_GNUM	PREINT	POINT_TO_GLIST1 POINT_TO_GLIST2 POINT_TO_GLIST3	PREINT
PORT_DETECT_GS	GS	DBP_MSG_INTRPRT	DCEXEC
PORT_DISCO_UPDATE	PREINT	RRU_UPDATE ZEROIZE	PREINT
PORT_DISCONNECT	DCMOW	FRAME_FMT_UPDATE FORMAT_UPDATE NUFMT_TO_STP	DCMOW PREINT
PORT_RELEASE_15	FP	FPANEL	FP
PORT_RELEASE_FP	FP	DCKPORTOFF_GS SHOW_PORT_GS CALL_CC_GS	GS GS GS
PORTCCADR_05	PREINT	CONFIG_ENTRY_05	PREINT
PORTCCADR_PREINT	PREINT	CONFIG_CODE_FP SLOT_CON_UPDATE RRU_STATUS_RPTB CALL_REQ_05 CONF_REQ_05 CONFIG_ENTRY_05	FP PREINT PREINT PREINT PREINT
PRE_DCKA_CHK_FP	FP	TO_PARTY_CALL_FP	FP
PREC_CONVERT_FP	FP	FPANEL TO_PARITY_CALL_FP	FP FP
PREC_ENTER_25	FP	FORMAT_FREQ_FP	FP
PREC_ENTER_30	FP	GLIST_DISP_LY_FP	FP
PREC_ENTER_FP	FP	OUT_OF_SERV_FP TO_PARITY_CALL_FP CONFER_CALL_FP	FP FP FP
PREC_TO_RCOW_GS	GS	DATA_XFER DATA_XFER RRU_PRTY_OUT CALL_REQ_05 CONF_REQ_05	DCMOW PREINT PREINT PREINT PREINT
PREEMPT_LITE	PRINT	RRU_DISCO	PREINT
PREEMPT_UPDATE	PRECLA	TIME_CHK_PRECLA	PRECLA
PREMPTCOUNT_05	PREINT	PREMPTCOUNT_REDO	PREINT
PREMPTCOUNT_REDO	PREINT	SLOT_CON_UPDATE SLOT_DISCONNECT CALL_COMPLETE	PREINT PREINT PREINT
PRSN	STPV06	SRX	STPV06
PRT_CNFIG_CHNG	PREINT	RRU_STATUS_RPTB	PREINT
PSA	STPV06	EXEC	STPV06
PTSN	STPV06	CONFIG STX	STPV06

Module Name	Located in	Is Called by	Located in
PVR	STPV06	SRX	STPV06
		BRX	STPV06
PVRA	STPV06	SRX	STPV06
PVT	STPV06	STX	STPV06
		BTX	STPV06
RAMT	DBPV4/STPV06	COLDS	STPV06
RCCOW_PORTADR_GS	GS	DATA_XFER	DCMOW
		INFO_REPORT	DCMOW
		RRRU_STATUS_RPTB	PREINT
		DATA_XFER	PREINT
		CALL_COMPLETE	PREINT
		RRU_PRTY_OUT_05	PREINT
		INFO_RPT_05	PREINT
		RRU_CALLCAN_15	PREINT
		PAGING_05	PREINT
		STATUS_RPT_A	PREINT
		LINK_RESULT	PREINT
		CALL_REQ_05	PREINT
		CONF_REQ_05	PREINT
RCOW_ASSIGN_FMT	PREINT	CALL_ACK_05	PREINT
		RCOW_ASSIGN_05	PREINT
RCOW_INTP_DCCNTR	DCCNTR	USEREXEC	DCEEXEC
RCOW_INTP_PRECLA	PRECLA	USEREXEC	PREALT
RCOW_OUT_PREINT	PRINT	USEREXEC	PREALT
RCOW_PREP_XMIT	DCEEXEC/PREALT	USEREXEC	DCEEXEC
		USEREXEC	PREALT
RCOW_XMIT_DCMOW	DCMOW	USEREXEC	DCEEXEC
RCV_CCOW_BLOCK	PRECLA	CC_EXEC_PRECLA	PRECLA
READ_ACIA	GS	TEST_ACIA	GS
READ_CALL_ACK	PREINT	MASTER_FRAME	PREINT
		COMMAND_FRAME	PREINT
READ_DBP_RCOW_GS	GS	DBP_MSG_INTRPRT	DCEEXEC
		DBP_MSG_INTRPRT	PREALT
REDO_DBP_PORT_GS	GS	DISCO_SLOT_CHK	DCMOW
		CALL_REQUEST	DCMOW
		CALL_COMPLETE	DCMOW
		INIT	PREALT
		RRU_TURNOFF	PRECLA
		SLOT_CON_UPDATE	PREINT
		PORT_DISCONNECT	PREINT
		CLEAR_SLOTS_GS	GS
REDO_RRUI_GS	GS	REDO_RRUS_DCMOW	DCMOW
		REDO_RRUS_PREINT	PREINT
		WRITE_ACIA	GS
REDO_RRU2_GS	GS	REDO_RRUS_DCMOW	DCMOW
		REDO_RRUS_PREINT	PREINT
		WRITE_ACIA	GS
REDO_RRU3_GS	GS	REDO_RRUS_DCMOW	DCMOW
		REDO_RRUS_PREINT	PREINT
		WRITE_ACIA	GS
REDO_RRU4_GS	GS	REDO_RRUS_DCMOW	DCMOW
		REDO_RRUS_PREINT	PREINT
		WRITE_ACIA	GS
REDO_RRUS_DCMOW	DCMOW	USEREXEC	DCEEXEC
		CCOW_INTP_DCMOW	DCMOW

Module Name	Located in	Is Called by	Located in
RRU_ACPT_ON_GS	GS	DATA_XFER CALL_REQUEST CALL_COMPLETE INFO_REPORT RRU_STATUS_RPTB DATA_XFER CALL_COMPLETE RRU_PRTY_OUT_05 INFO_RPT_05 RRU_CALLCAN_15 PAGING_05 CALL_REQ_05 CONF_REQ_05	DCMOW DCMOW DCMOW DCMOW PREINT PREINT PREINT PREINT PREINT PREINT PREINT PREINT PREINT PREINT
RRU_B2_LOOP_CHK	DCEXEC/PREALT	RCOW_PREP_XMIT	DCEXEC
RRU_CLEAR_BIT_GS	GS	RCOW_PREP_XMIT STP_MSG_INTRPRT CLR_RRU_PREC_DSP FPANEL CLR_RRU_PREC_DSP STP_MSG_INTRPRT MASTER_FRAME	PREALT DCEXEC DCEXEC FP PREALT PREALT PREINT
RRU_DISCO	PREINT	CHK_USER_NR1 CHK_USER_NR2	PREINT PREINT
RRU_INTRPRT	DCMOW/PREINT	RRU_MSG_IN_DCMOW RRUMSG_IN_PREINT	DCMOW PREINT
RRU_MSG_IN_DCMOW	DCMOW	USERPREAC	DCEXEC
RRU_MSG_UPDATE	PREALT	USEREXEC USERPREAC USEREXEC USERPREAC	DCEXEC PREALT PREALT
RRU_OUT_ADR	PREINT	BUSY_ACK CALL_ACK	PREINT PREINT
RRU_SET_BIT_GS	GS	STP_MSG_INTRPRT RRU_MSG_UPDATE FPANEL STP_MSG_INTRPRT RRU_MSG_UPDATE MASTER_FRAME	DCEXEC DCEXEC FP PREALT PREALT PREINT
RRU_TURNOFF	PRECLA	TIME_CHK_PRECLA	PRECLA
RRU_XMIT_SET_GS	GS	USEREXEC USERPREAC USEREXEC USERPREAC	DCEXEC DCEXEC PREALT PREALT
RRUMSG_IN_PREINT	PREINT	USEREXEC USERPREAC	PREALT PREALT
RRUOUTAD2_PREINT	PREINT	FRAME_CHK_PRECLA BUSY_ACK CALL-ACK_05 CALL_ACK	PRECLA PREINT PREINT PREINT
SAVE_STP11_GS	GS	DISCO_SLOT_CHK INIT RRU_TURNOFF SLOT_CON_UPDATE PORT_DISCONNECT	DCMOW PREALT PРЕCLA PREINT PREINT

Module Name	Located in	Is Called by	Located in
SAVE_STP12_GS	GS	SWITCH_RED AC_HOME_FREQ_FP EXEC_PREALT USEREXEC EXAM_CCOW_OVRHED HOME_CHAN_05	DCEXEC FP PREALT PREALT PRECLA PREINT
SAVE_STP13_GS	GS	TIME_CHK_DCCNTR EXEC_DCEXEC USEREXEC STP_MSG_INTRPRT MASTER_FRAME SETUP USERPREAC STP_MSG_INTRPRT EXAM_CCOW_OVRHED STATUS_PRECLA CC_EXEC_PRECLA	DCCNTR DCEXEC DCEXEC DCEXEC DCMOW PREALT PREALT PREALT PRECLA PRECLA PRECLA
SAVE_STP18_GS	GS	TIME_CHK_DCCNTR STATUS_DCCNTR USEREXEC USERPREAC STP_MSG_INTRPRT MASTER_FRAME RCOW_XMIT_DCMOW USEREXEC STP_MSG_INTRPRT EXAM_CCOW_OVRHED TIME_CHK_PRECLA STATUS_PRECLA RCOW_OUT_PREINT MASTER_FRAME LINK_TEST_ASSIGN	DCCNTR DCCNTR DCEXEC DCEXEC DCEXEC DCMOW DCMOW PREALT PREALT PRECLA PRECLA PRECLA PREINT PREINT PREINT PREINT
SAVE_SW3_GS	GS	SETUP_MISC AC_HOME_FREQ_FP INIT SETUP EXAM_CCOW_OVRHED HOME_CHAN_05	DCEXEC FP PREALT PREALT PRECLA PREINT
SCCNV	STPV06	EXEC	STPV06
SEL_PORT_DISCO	PREINT	SLOT_DISCONNECT RRU_DISCO SLOT_CON_UPDATE CALL_COMPLETE	PREINT PREINT PREINT PREINT
SELECT_PORT_FP	GP	JUMP_SELECT_1_GS JUMP_SELECT_2_GS	GS GS
SEND_CCOW_BLOCK	PRECLA	CC_EXEC_PRECLA	PRECLA
SEND_RCOW_TO_SAC	PRECLA	CC_EXEC_PRECLA	PRECLA
SEQUENCE_LITES	DCCNTR	FRAME_CHK_DCCNTR	DCCNTR
SET_DBPSTAT_MSG	DCCNTR/PRECLA	STATUS_DCCNTR STATUS_PRECLA	DCCNTR PRECLA
SET_GLIST_FLAG	PREINT	GLIST_ENTDEL_10 GLIST_ENTDEL_30	PREINT PREINT
SET_GLIST_PTR	PREINT	RPT_GLIST1 RPT_GLIST2 RPT_GLIST3 RPT_GLIST4	PREINT PREINT PREINT PREINT

Module Name	Located in	Is Called by	Located in
SET_MSG_CODE	PREINT	RPT_GLIST1	PREINT
		RPT_GLIST2	PREINT
		RPT_GLIST3	PREINT
		RPT_GLIST4	PREINT
SET_PORT_CC	DCCNTR/PRECLA	STATUS_DCCNTR	DCCNTR
		STATUS_PRECLA	PRECLA
SET_PREMPT_FLAG	PREINT	RRU_DISCO	PREINT
		SLOT_CON_UPDATE	PREINT
SET_SC_FLAG	PREINT	SET_XMIT_FLAG	PREINT
		RRU_DISCO	PREINT
SET_TIME_CODE	PREINT	SLOT_CON_UPDATE	PREINT
		INIT	PREALT
SETUP_MISC	DCEEXEC/PREALT	INIT_DCEEXEC	DCEEXEC
SETUP1	DBPV4/DCMOW	PWRON	DBPV4
		TDMA	DBPV4
SHIFT_EVEN_PORT	PREINT	STATUS_RPT_A	PREINT
SHIFT_ODD_PORT	PREINT	STATUS_RPT_A	PREINT
SHIFITLEFT	GS	LOAD_KG_VARS_GS	GS
SHIFTRIGHT	GS	LOAD_KG_VARS_GS	GS
SHOW_PORT_GS	GS	PORT_DETECT_GS	GS
SHOW_WX_GS	GS	KG_TIME_TO_DSPLY	FP
		DISP_VWXYZ_GS	GS
SHOW_YZ_GS	GS	BCD_TO_YZ_FP	FP
		AC_HOME_FREQ_FP	FP
		KG_TIME_TO_DSPLY	FP
		DISP_VWXYZ_GS	GS
		DISP_INFO_REQ_GS	GS
SHOWOUT_YZ_GS	GS	FPANEL	FP
		CONFIG_CODE_FP	FP
SLOT_CON_UPDATE	PREINT	SLOT_CONNECT	PREINT
SOFA	DBPV4	SOF	DBPV4
SOFAA	DBPV4	RBIT	DBPV4
SRX	STPV06	CONS	STPV06
SST	STPV06	RCW1	STPV06
		RR2	STPV06
STATUS_DCCNTR	DCCNTR	EXEC_DCEEXEC	DCEEXEC
STATUS_PRECLA	PRECLA	EXEC_PREALT	PREALT
STC	STPV06	CONFIG_CODE_FP	STPV06
STC4	STPV06	STC	STPV06
STG_LITE_UPDATE	FP	STG_CONTROL_FP	FP
STP_MSG_INTRPRT	DCEEXEC/PREALT	USEREXEC	DCEEXEC
		USERPREAC	DCEEXEC
		USEREXEC	PREALT
		USERPREAC	PREALT
STRAP_05	GS	STRAP_READ_GS	GS
STRAP_READ_GS	GS	INIT_DCEEXEC	DCEEXEC
		SETUP_MISC	DCEEXEC
		INIT	PREALT
		TDMA	DBPV4
STUFF	DBPV4	CONS	STPV06
STX	STPV06	PORT_DETECT_GS	GS
SUB_KG_TIME_GS	GS	EXEC_DCEEXEC	DCEEXEC
SWAPLITES_DCEEXEC	DCEEXEC	USEREXEC	DCEEXEC
		STP_MSG_INTRPRT	DCEEXEC
		MASTER_FRAME	DCMOW
		CHAN_CONTROL_FP	FP

Module Name	Located in	Is Called by	Located in
SWITCH_REDO	DCEXEC	EXEC_DCEXEC	DCEXEC
SWITCHIT_GS	GS	EXEC_DCEXEC	DCEXEC
		SWITCH_REDO	DCEXEC
		EXEC_PREALT	PREALT
TEST_ACIA	GS	INTERRUPT_GS	GS
TIME_CHK_DCCNTR	DCCNTR	USEREXEC	DCEXEC
		USERPREAC	DCEXEC
TIME_CHK_PRECLA	PRECLA	USEREXEC	PREALT
		USERPREAC	PREALT
TIME_DELAY	DCMOW/PREINT	INFO_REPORT	DCMOW
		RRU_STATUS_RPTB	PREINT
		PAGING_05	PREINT
		INFO_RPT_05	PREINT
		CALL_COMPLETE	PREINT
TIME_FMT	PREINT	RRU_DISCO	PREINT
		SLOT_CON_UPDATE	PREINT
		CALL_QUE_UPDATE	PREINT
		PORT_DISCO_UPDATE	PREINT
TS_PREP_DCEXEC	DCEXEC	FRAME_CHK_DCCNTR	DCCNTR
		USERPREAC	DCEXEC
TS_PREP_PREALT	PREALT	USERPREAC	PREALT
		FRAME_CHK_PRECLA	PRECLA
TST_XMITD_QUE	PREINT	BUSY_ACK	PREINT
		READ_CALL_ACK	PREINT
UNPACK_GS	GS	FPANEL	FP
		INFO_REQ_CHK_FP	FP
		FREQ_TO_DSPLY_FP	FP
		CONFIG_CODE_FP	FP
		SHOW_YZ_GS	GS
		SHOW_WX_GS	GS
USER1_SETUP_GS	GS	ZEROIZE	DCMOW
		INFO_REQUEST_GS	GS
		SLOT_DISCONNECT	PREINT
		PARTY_OUT_OF_SVC	PREINT
		USER1_SETUP_GS	PREINT
		ZEROIZE	PREINT
		CCOW_DATA_XFER	PREINT
		CALL_IN_QUE	PREINT
		CALL_WAITING	PREINT
		DELET_GUARD_LIST	PREINT
		ENTER_GUARD_LIST	PREINT
		HOME_CHAN_CHANG	PREINT
		CALL_CANCEL	PREINT
		FORMAT_CHANGE	PREINT
		SLOT_CONNECT	PREINT
		LINK_TEST_ASIGN	PREINT

Module Name	Located in	Is Called by	Located in
USER2_SETUP	PREINT	ZEROIZE SLOT_DISCONNECT SLOT_CONNECT FORMAT_CHANGE CALL_CANCEL HOME_CHAN_CHANG ENTER_GUARD_LIST DELET_GUARD_LIST CALL_IN_QUE ZEROIZE PARTY_OUT_OF_SVC	DCMOW PREINT PREINT PREINT PREINT PREINT PREINT PREINT PREINT PREINT
USER3_SETUP	PREINT	CALL_CANCEL HOME_CHAN_CHANG ENTER_GUARD_LIST DELET_GUARD_LIST	PREINT PREINT PREINT PREINT
USEREXEC	DCEXEC/PREALT	EXEC_DCEXEC EXEC_PREALT	DCEXEC PREALT
USERPREAC	DCEXEC/PREALT	EXEC_DCEXEC EXEC_PREALT	DCEXEC PREALT
VWXYZ_TO_BIN_FP	FP	ZEROIZE_FP GLIST_DELETE_FP PAGING_REQ_FP GLIST_ENTER_FP INFO_REPORT_FP TO_PARITY_CALL_FP CONFER_CALL_FP	FP FP FP FP FP FP
WRITE_ACIA	GS	TEST_ACIA	GS
WX_TO_BCD_FP	FP	KG_TIME_FP INFO_REQUEST_FP	FP FP
XFER_CCOW_TO_DBP	DCEXEC	EXEC_DCEXEC	DCEXEC
XFER_OW	PREALT	EXEC_PREALT	PREALT
XFER_RCOW_DBP_GS	GS	EXEC_DCEXEC RCOW_PREP_XMIT RCOW_PREP_XMIT	DCEXEC PREALT
XPLUSA_GS	GS	FRAME_CHK_DCCNTR CALL_REQUEST SEQUENCE_LITES RCOW_INTP_DCCNTR RRU_B2_LOOP_CHK SWAPLITES_DCEXEC CALL_REQUEST INFO_REQ_CHK_FP INIT RRU_B2_LOOP_CHK RCOW_INTP_PRECLA FORMAT_GLIST_RCW MASTER_FRAME RRU_DISCO CHK_GLIST XPLUSB_GS RRU_CLEAR_BIT_GS RRU_SET_BIT_GS	DCCNTR DCCNTR DCCNTR DCEXEC DCEXEC DCMOW FP PREALT PREALT PRECLA PREINT PREINT PREINT PREINT GS GS GS

Module Name	Located in	Is Called by	Located in
XPLUSB_GS	GS	FORMAT_FREQ_FP	FP
		DC_HOME_FREQ_FP	FP
		FREQ_TO_DSPLY_FP	FP
		CALL_COMPLETE	DCMOW
		CALL_REQUEST	DCMOW
		BIT_RATE_FIND	DCMOW
YZ_TO_BCD_FP	FP	OUT_OF_SERV_FP	FP
		DC_HOME_FREQ_FP	FP
		KG_TIME_FP	FP
		INFO_REQUEST_FP	FP
YZ_TO_BIN_FP	FP	CONFER_CALL_FP	FP
ZERO_SLOTS_GS	GS	STATUS_DCCNTR	DCCNTR
		ZEROIZE	DCMOW

Module Name	Located in	Is Called by	Located in
ZEROFILL_GS	GS	SPECIAL_CCOW	DCCNTR
		TIME_CHK_DCCNTR	DCCNTR
		STATUS_DCCNTR	DCCNTR
		EXEC_DCEXEC	DCEXEC
		STP_MSG_INTRPRT	DCEXEC
		RCOW_XMIT_DCMOW	DCMOW
		CHAN_CONTROL_FP	FP
		EXEC_PREALT	PREALT
		STP_MSG_INTRPRT	PREALT
		TIME_CHK_PRECLA	PRECLA
		STATUS_PRECLA	PRECLA
		MASTER_FRAME	PREINT
		CONF_REQ_05	PREINT
		REDO_RRU1_GS	GS
		CLEAR_SLOTS_GS	GS

APPENDIX C

A. PARSER.ADA

```
with text_io; use text_io;
procedure parser is

    package int_io is new integer_io(integer);
    use int_io;

    subtype label_range is integer range 1..6;
    subtype opcode_range is integer range 8..13;
    subtype operand_range is integer range 15..20;

    subtype str6  is string(1..6);
    subtype str120 is string(1..120);

    type call_node;
    type call_node_ptr is access call_node;

    type call_node is record
        caller : integer;
        next   : call_node_ptr;
    end record;

    type label_node;
    type label_node_ptr is access label_node;

    type label_node is record
        label      : str6;
        called_by : call_node_ptr;
        line      : integer;
        next      : label_node_ptr;
    end record;

    label_list   : label_node_ptr := null;
    new_label    : label_node_ptr;
    search       : label_node_ptr;
    label        : str6;
    opcode       : str6;
    operand      : str6;
    col_nbr      : natural;
    new_caller   : call_node_ptr;
    input_file   : file_type;
    output_file  : file_type;

    procedure establish_label_list is
        line      : str120;
        line_nbr : integer := 0;
        count    : natural;
        debug    : boolean := false;
        found    : boolean;
    begin
        while not end_of_file(input_file) loop
```

```

get_line(input_file, line, count);
line_nbr := line_nbr + 1;
put(output_file, line_nbr, 4);
put_line(output_file, " " & line(1..count));
-- CHECK IF THE LINE HAS A LABEL
if count > 0 then
  if line(1) >= 'A' and line(1) <= 'Z' then
    if count >= 7 then
      label := line(label_range);
      if debug then put_line("LABEL IS " & label); end if;

      -- CHECK AND SEE IF THE LABEL EXISTS
      search := label_list;
      found := false;
      while search /= null loop
        if search.label = label then
          found := true;
        end if;
        search := search.next;
      end loop;
      if debug then put_line("SEARCHED FOR LABEL - " &
        boolean'image(found)); end if;
      if not found then
        -- ENTER THE LABEL INTO THE END OF THE LINKED LIST
        new_label := new_label_node;
        new_label.label := label;
        new_label.next := null;
        new_label.line := line_nbr;
        search := label_list;
        if search = null then
          -- FIRST ITEM IN THE LIST
          label_list := new_label;
        else
          while search.next /= null loop
            search := search.next;
          end loop;
          search.next := new_label;
        end if;
      end if;
      end if; -- count > 7
    end if; -- 'A' or 'Z'
  end if; -- count > 0
end loop;
end establish_label_list;

procedure parse_control is
  line      : str120;
  count     : natural;
  line_count : integer := 0;
  debug     : boolean := false;
  found     : boolean;
  caller    : call_node_ptr;

  function control_opcode(opcode : str6) return boolean is
    debug : boolean := false;
begin
  if debug then put(opcode); end if;

```

```

if opcode = "BCC" " or
  opcode = "BCS" " or
  opcode = "BEQ" " or
  opcode = "BGE" " or
  opcode = "BGT" " or
  opcode = "BHI" " or
  opcode = "BLE" " or
  opcode = "BLS" " or
  opcode = "BLT" " or
  opcode = "BMI" " or
  opcode = "BNE" " or
  opcode = "BPL" " or
  opcode = "BRA" " or
  opcode = "BSR" " or
  opcode = "BVC" " or
  opcode = "BVS" " or
  opcode = "JMP" " or
  opcode = "JSR" " then
  if debug then put_line(" - TRUE"); end if;
  if debug then skip_line; end if;
  return true;
else
  if debug then put_line(" - FALSE"); end if;
  if debug then skip_line; end if;
  return false;
end if;
end control_opcode;

begin
  while not end_of_file(input_file) loop
    get_line(input_file, line, count);
    for i in count + 1 .. line'last loop
      line(i) := ' ';
    end loop;

    line_count := line_count + 1;
    if debug then put_line(line(1..count)); end if;
    -- CHECK IF THE LINE ISN'T A COMMENT
    if line(1) /= '*' then
      -- NOT A COMMENT

      opcode := line(opcode_range);
      operand := line(operand_range);

      if control_opcode(opcode) then
        if debug then put_line("FOUND BRANCH OPCODE - LOOKING FOR " &
operand); end if;
        -- SEARCH THE LABEL LIST FOR THE OPERAND
        search := label_list;
        found := false;
        while not found loop
          --if debug then put_line("COMPARING " & operand & " TO " &
search.label); end if;
          if operand = search.label then
            -- FOUND MATCH, ADD CURRENT LINE NUMBER TO LIST
            if debug then put_line("FOUND MATCHING LABEL - ADDING
LINE NUMBER"); end if;

```

```

-- ADD TO END
new_caller      := new call_node;
new_caller.next := null;
new_caller.caller:= line_count;
if search.called_by = null then
    search.called_by := new_caller;
else
    caller := search.called_by;
    while caller.next /= null loop
        caller := caller.next;
    end loop;
    caller.next := new_caller;
end if;
found := true;
else
    search := search.next;
    if search = null then
        put_line("COULD NOT FIND LABEL " & operand & " AT LINE
" & integer'image(line_count));
        found := true;
    end if;
    end if;
    end loop;
end if;
end if;
if debug then skip_line; end if;
end loop;
end parse_control;

procedure report_results is
begin
while label_list /= null loop
    put(label_list.label & " (");
    if label_list.line < 10 then
        put(label_list.line, 1);
    elsif label_list.line < 100 then
        put(label_list.line, 2);
    elsif label_list.line < 1000 then
        put(label_list.line, 3);
    else
        put(label_list.line, 4);
    end if;
    put(" )");
    while label_list.called_by /= null loop
        put(" ");
        put(label_list.called_by.caller, 4);
        label_list.called_by := label_list.called_by.next;
    end loop;
    label_list := label_list.next;
    new_line;
end loop;
end report_results;

begin
open(input_file, in_file, "s_dbp.src");
create(output_file, out_file, "s_dbp.lst");
establish_label_list;

```

```
close(input_file);
close(output_file);
open(input_file, in_file, "s_dbp.src");
parse_control;
close(input_file);
report_results;
end parser;
```


APPENDIX D

A. DATA BUFFER PROCESSOR SOURCE CODE LISTING

```
1 ****
2 *
3 *      BEGIN POWER ON INIT
4 *
5     ORG      ODC00H
6 PWRON  LDS      #00FFFH
7     SEI
8     LDX      #IRS
9     STX      OFFF8H
10    STAA     MPUB
11    JSR      INIT
12    STAA     BRATE1   SET BIT RATES = 75 BPS
13    STAA     BRATE2
14    LDAA     #055H    **TEST RAM**
15    CLRB
16 RAMT   LDX      #OFFCH
17 RAMTST STAA     0,X
18 CMPA
19 BNE     RAMERR
20 STAA     MPUB
21 DEX
22 BNE     RAMTST
23 TSTB
24 BNE     TSTROM
25 LDAA     #0AAH    TEST OTHER RAM BITS
26 INCB
27 BRA     RAMT
28 TSTROM JSR      ROMTST    **NOP FOR TESTING**
29 JSR      CLEAR
30 BRA     PWRON1
31 RAMERR LDAA     #020H    **RAM ERROR**
32 STAA     LATCH2    ****
33 STAA     MPUB     CRASH
34 BRA     RAMERR    ****
35 ****
36 *
37 *
38 ROMTST CLRA      **TEST ROM**
39     CLRB
40     LDX      #PWRON
41 ROMTSA ADDA     0,X
42 ADCB     #0
43 STAA     MPUB
44 INX
45 CPX      #PGMTOP
46 BNE     ROMTSA
47 CMPA     CKSMA
48 BNE     ROMERR
49 CMPB     CKSMB
```

```

50      BNE    ROMERR
51      RTS
52 *
53 ROMERR LDAA #040H **ROM ERROR**
54      STAA LATCH2 *****
55      STAA MPUB CRASH
56      BRA  ROMERR *****
57 *
58 PWRON1 JSR   SETUP1
59      LDAA PIA1AD CLEAR LATCHED INPUTS
60      LDAA PIA1BD
61      LDAA #09DH ENABLE INTERRUPTS ON ACIA
62      STAA ACIACS
63      CLI
64      JMP   TDMA
65 ****
66 *
67 *
68 INIT   LDAA #01FH  MASTER RESET ACIA
69      STAA ACIACS DISABLE INTERRUPTS
70      LDAA #0FH
71      STAA LATCH3 RESET I/O FIFOs
72      CLRA
73      STAA PIA1AC
74      STAA PIA1BC
75      STAA IO1+1
76      STAA IO1+3
77      STAA IO2+1
78      STAA IO2+3
79      STAA IO3+1
80      STAA IO3+3
81      STAA IO4+1
82      STAA IO4+3
83      STAA IO1 SET DATA DIRECTION REG
84      STAA IO2 A - SIDE = INPUTS
85      STAA IO3 FOR I/O PORT
86      STAA IO4
87      COMA
88      STAA PIA1AD
89      STAA PIA1BD
90      STAA IO1+2 B-SIDE = OUTPUTS
91      STAA IO2+2 FOR I/O PORT
92      STAA IO3+2
93      STAA IO4+2
94      LDAA #03EH SET CONTROL REG
95      STAA PIA1AC
96      LDAA #02EH
97      STAA IO1+1
98      STAA IO1+3
99      STAA IO2+1
100     STAA IO2+3
101     STAA IO3+1
102     STAA IO3+3
103     STAA IO4+1
104     STAA IO4+3
105     STAA PIA1BC
106     LDAA PIA1AD CLEAR LATCHED INPUTS

```

```

107      LDAA    PIA1BD
108      CLRA
109      STAA    PIA1AD
110      STAA    LATCH1    CLEAR SIGNAL ACQ. LINES
111      STAA    LATCH2
112      RTS
113 ****
114 *
115 *
116 CLEAR  CLRA          CLEAR RAM MEMORY
117      LDX     #OFF8H
118 CLEARA STAA 0,X
119      DEX
120      BNE    CLEARA
121      STAA    INPT1
122      RTS
123 ****
124 *
125 *
126 SETUP  BSR   CLEAR
127 SETUP1 INCA
128      STAA    TDMAFG  SETUP RCCOW & CCOW PORTS
129      INCA
130      STAA    MSDO1
131      STAA    MSDO2
132      STAA    MSDO3
133      STAA    MSDO4
134      LDAA    #0FH    INIT FIFO MR INFO
135      STAA    MRFPA
136      STAA    LATCH3
137      LDX     #ERCRX
138      STX     RCRXPT
139      LDAA    DATA1    CHECK FOR 'TEST 1' MODE
140      BITA    #010H
141      BEQ    SETUP3
142      LDAA    #0FH
143      STAA    PTONRX
144      LDAA    #024H
145      STAA    BRATE1  INIT BIT RATES
146      STAA    BRATE2  FOR TEST #1 MODE:
147      LDAA    #020H    ALL = 2400 BPS
148      STAA    CHRAT1
149      STAA    CHRAT2
150      STAA    CHRAT3
151      STAA    CHRAT4
152 SETUP3 RTS
153 ****
154 *
155 *
156 TDMA   STAA    MPUB    ***BITE OUTPUT***
157      LDAA    DATA1    CHECK TDMA SWITCH FLAG
158      BITA    #020H    OF T&C PROCESSOR
159      BNE    TDMA1
160      LDAB    TDMAFG
161      BNE    TDMAI
162 ****
163 *

```

```

164 *NON-TDMA SERVICE
165 *
166     BITA    #01H      CHECK NON-TDMA TX REQ
167     BEQ     TDMAA
168     LDAA    #01FH     SET TX ACK
169     BRA     TDMAB
170 TDMAA  LDAA    #0FH      CLEAR TX ACK
171 TDMAB  STAA    LATCH3
172     BRA     TDMA
173 *
174 TDMAI  SEI
175     JSR     INIT      INIT. FOR NON-TDMA
176     CLR     TDMAFG
177     CLR     PIA1BD
178     LDAA    DATA3     RESET TX FIFO
179     LDAA    #036H
180     STAA    PIA1AC   STROBE "NON-TDMA START"
181     LDAA    #03EH
182     STAA    PIA1AC
183     BRA     TDMA
184 *
185 TDMA1  LDAA    TDMAFG
186     BNE     RBI
187     STAA    PTONRX   TURN ALL PORTS OFF
188     BSR     SETUP1   INIT FOR TDMA
189     LDAA    #09DH     ENABLE RX INTERRUPTS
190     STAA    ACIACS
191     CLI
192 ****
193 *
194 *
195 RBI    LDAA    PIA1AC   CHECK RCV SETUP RDY
196     BMI     RBIA
197     JMP     TBI
198 RBIA   LDAB    SIEN
199     BEQ     RBIB
200     LDAB    BITELT   SYST INPUT FIFO BITE
201     ORAB    #020H     (RX FIFO)
202     STAB    BITELT
203     CLR     SIEN     CLEAR INPUT FIFO FLAGS
204     CLR     SELFTR
205     CLR     FILLFG
206     CLR     INPTRC
207 *
208 ***** BEGIN RECEIVE BURST INIT *****
209 *
210 RBIB   LDAB    PIA1AD   CLR LATCHED STROBE
211     LDAA    DATA4     LOAD RCV SETUP DATA
212     LDAB    SELFTR
213     BEQ     RBIBA
214     LDAB    BITELT   *SELF TEST FAIL BITE*
215     ORAB    #080H
216     STAB    BITELT
217 RBIBA  ANDA    #0C7H
218     TAB
219     ANDA    #7
220     CLR     MASKIO

```

```

221      CMPA    #1
222      BEQ     RBI1C
223      JMP     RBI2B
224 *
225 RBI1C  LDAA   XMTRQ1  **PORT #1 RX BURST INIT**
226      BEQ     RBI1CA
227      JMP     TBI
228 RBI1CA LDAA   PTONRX
229      ANDA   #1
230      BNE     RBI1D
231      JMP     TBI
232 RBI1D  ORAB   CHRAT1
233      LDAA   UT1
234      BEQ     RBI1E
235      LDAA   DATA6   CHECK FIFO'S "O.R."
236      BITA   #8
237      BNE     RBI1DA
238      LDAA   BITELT  ***I/O FIFO #1 BITE***
239      ORAA   #2
240      STAA   BITELT
241 RBI1DA CLR    UT1
242 RBI1E  LDAA   #1
243      STAA   MASKIO  INIT I/O ON/OFF MASK
244      TSTB
245      BMI    RBI1G
246      LDAA   MSDO1
247      BEQ    RBI1EA
248      CLR    FLBFG1  TWO OR MORE MISSING DO'S
249      LDAA   #2
250      STAA   MSDO1
251      JMP    TBI
252 RBI1EA INCA   **FIRST MISSING DO SETUP**
253      STAA   FMSDO1
254      STAA   MSDO1
255      STAA   FILLFG  SETUP TO STUFF
256      LDAA   CHCT1  "FF" INTO BUFFER
257      LDAB   CHCT1+1
258      ADDB   #32    ADJ COUNT FOR I/O FIFO
259      ADCA   #0
260      STAA   MDOCT1
261      STAB   MDOCT1+1
262      LDAB   CHRAT1
263      BRA    RBI1H1
264 RBI1G  LDAA   MSDO1
265      CMPA   #2    TWO OR MORE MISSING DO'S?
266      BNE    RBI1H
267      LDAA   MRFTA
268      ORAA   #1    RESET I/O #1 FIFO
269      STAA   MRFTA
270      STAA   LATCH3
271 RBI1GA LDX    #SBUFF1 INIT BUFFER #1 AND
272      STX    OUTPT1 I/O FIFO #1
273      STAA   FLBFG1
274      CLRA
275      STAA   CHCT1
276      LDAA   #0FFH   **RX ELAST BUFF CH**
277      TST    BPS16K  16KBPS?

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```

278      BEQ      RBI1GB
279      JSR      STUFF     16 KBPS ELASTIC BUF. CHARS.
280      STX      INPT1
281      LDX      #256     17 MIN. ELASTIC BUFF
282      STX      CHCT1
283      BRA      RBI1H
284 RBI1GB STAA    SBUFF1   RCV BURST
285          STAA    SBUFF1+1
286          STAA    SBUFF1+2
287          STAA    SBUFF1+3
288          STAA    SBUFF1+4
289          LDAA    #5
290          STAA    CHCT1+1
291          LDX     #SBUFF1+5
292          STX     INPT1
293 RBI1H CLR     MSDO1
294 RBI1H1 LDX     #INPT1   INIT FOR INPUT
295          STX     RXPNTR   FIFO SERVICE
296          LDAA    BPS16K
297          BEQ     RBI1HA  16 KBPS?
298          LDX     #EBUFF4
299          STX     RXUVAL   INIT 16 KBPS BUFFER PNTRS.
300          LDX     #SBUFF1
301          STX     RXLVAL
302          BRA     RBI1HB
303 RBI1HA LDX     #EBUFF1
304          STX     RXUVAL
305          LDX     #SBUFF1
306          STX     RXLVAL
307 RBI1HB LDAA    SIGACQ   SET "SIGNAL ACQ. I/O #1"
308          ORAA   #1
309          STAA    SIGACQ
310          STAA    LATCH1
311          JMP     RBIS
312 *
313 RBI2B CMPA    #2
314          BEQ     RBI2C
315          JMP     RBI3B
316 RBI2C LDAA    XMTRQ2  **PORT #2 BURST INIT**
317          BEQ     RBI2CA
318          JMP     TBI
319 RBI2CA LDAA    PTONRX
320          ANDA   #2
321          BNE     RBI2D
322          JMP     TBI
323 RBI2D ORAB    CHRAT2
324          LDAA   UT2
325          BEQ     RBI2E
326          LDAA   DATA6    CHECK FIFO'S "O.R."
327          BITA   #4
328          BNE     RBI2DA
329          LDAA   BITELT   ***I/O FIFO #2 BITE***
330          ORAA   #4
331          STAA   BITELT
332 RBI2DA CLR     UT2
333 RBI2E LDAA    #2
334          STAA   MASKIO   INIT I/O ON/OFF MASK

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```

335      TSTB
336      BMI    RBI2G
337      LDAA   MSDO2
338      BEQ    RBI2EA
339      CLR    FLBFG2  TWO OR MORE MISSING DO'S
340      LDAA   #2
341      STAA   MSDO2
342      JMP    TBI
343 RBI2EA INCA      **FIRST MISSING DO SETUP**
344      STAA   FMSDO2
345      STAA   MSDO2
346      STAA   FILLFG  SETUP TO STUFF
347      LDAA   CHCT2  "FF" INTO BUFFER
348      LDAB   CHCT2+1
349      ADDB   #32    ADJ COUNT FOR I/O FIFO
350      ADCA   #0
351      STAA   MDOCT2
352      STAB   MDOCT2+1
353      LDAB   CHRAT2
354      BRA    RBI2H1
355 RBI2G  LDAA   MSDO2
356      CMPA   #2    TWO OR MORE MISSING DO'S?
357      BNE    RBI2H
358      LDAA   MRFTA
359      ORAA   #2    RESET I/O #2 FIFO
360      STAA   MRFTA
361      STAA   LATCH3
362 RBI2GA LDX   #SBUFF2  INIT BUFFER #2 AND
363      STX    OUTPT2 I/O FIFO #2
364      STAA   FLBFG2
365      CLRA
366      STAA   CHCT2
367      LDAA   #0FFH  **RX ELAST BUFF CH**
368      TST    BPS16K 16KBPS?
369      BEQ    RBI2GB
370      JSR    STUFF   16KBPS ELASTIC BUF. CHARS.
371      STX    INPT2
372      LDX   #256   17 MIN ELAST BUFF
373      STX    CHCT2
374      LDX   #SBUFF1
375      STX    OUTPT2
376      BRA    RBI2H
377 RBI2GB STAA   SBUFF2  RCV BURST
378      STAA   SBUFF2+1
379      STAA   SBUFF2+2
380      STAA   SBUFF2+3
381      STAA   SBUFF2+4
382      LDAA   #5
383      STAA   CHCT2+1
384      LDX   #SBUFF2+5
385      STX    INPT2
386 RBI2H  CLR    MSDO2
387 RBI2H1 LDX   #INPT2  INIT FOR INPUT
388      STX    RXPNTR  FIFO SERVICE
389      LDAA   BPS16K
390      BEQ    RBI2HA  16 KBPS?
391      LDX   #EBUFF4

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392      STX      RXUVAL   INIT. 16KBPS BUF. PNTRS.
393      LDX      #SBUFF1
394      STX      RXLVAL
395      BRA      RBI2HB
396 RBI2HA LDX      #EBUFF2
397      STX      RXUVAL
398      LDX      #SBUFF2
399      STX      RXLVAL
400 RBI2HB LDAA     SIGACQ   SET "SIGNAL ACQ. I/O #2"
401      ORAA    #2
402      STAA    SIGACQ
403      STAA    LATCH1
404      JMP     RBIS
405 *
406 RBI3B  CMPA    #3
407      BEQ     RBI3C
408      JMP     RBI4B
409 RBI3C  LDAA     XMTRQ3   **PORT #3 BURST INIT**
410      BEQ     RBI3CA
411      JMP     TBI
412 RBI3CA LDAA     PTONRX
413      ANDA    #4
414      BNE     RBI3D
415      JMP     TBI
416 RBI3D  ORAB     CHRAT3
417      LDAA    UT3
418      BEQ     RBI3E
419      LDAA    DATA6    CHECK FIFO'S "O.R."
420      BITA    #2
421      BNE     RBI3DA
422      LDAA    BITELT   **I/O FIFO #3 BITE***
423      ORAA    #8
424      STAA    BITELT
425 RBI3DA CLR      UT3
426 RBI3E  LDAA    #4
427      STAA    MASKIO   INIT I/O ON/OFF MASK
428      TSTB
429      BMI     RBI3G
430      LDAA    MSDO3
431      BEQ     RBI3EA
432      CLR      FLBFG3
433      LDAA    #2
434      STAA    MSDO3
435      JMP     TBI
436 RBI3EA INCA    **FIRST MISSING DO SETUP**
437      STAA    FMSDO3
438      STAA    MSDO3
439      STAA    FILLFG   SETUP TO STUFF
440      LDAA    CHCT3   "FF" INTO BUFFER
441      LDAB    CHCT3+1
442      ADDB    #32     ADJ COUNT FOR I/O FIFO
443      ADCA    #0
444      STAA    MDOCT3
445      STAB    MDOCT3+1
446      LDAB    CHRAT3
447      BRA     RBI3H1
448 RBI3G  LDAA    MSDO3

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449      CMPA    #2      TWO OR MORE MISSING DO'S?
450      BNE     RBI3H
451      LDAA    MRFTA
452      ORAA    #4      RESET I/O FIFO #3
453      STAA    MRFTA
454      STAA    LATCH3
455 RBI3GA LDX    #SBUFF3  INIT BUFFER #3 AND
456      STX     OUTPT3  I/O FIFO #3
457      STAA    FLBFG3
458      CLRA
459      STAA    CHCT3
460      LDAA    #0FFH   **RX ELAST BUFF CH**
461      TST     BPS16K  16KBPS?
462      BEQ     RBI3GB
463      JSR     STUFF   16 KBPS ELASTIC BUF. CHARS.
464      STX     INPT3
465      LDX    #256    17 MIN ELASTIC BUFF .
466      STX     CHCT3
467      LDX    #SBUFF1
468      STX     OUTPT3
469      BRA     RBI3H
470 RBI3GB STAA   SBUFF3  RCV BURST
471      STAA   SBUFF3+1
472      STAA   SBUFF3+2
473      STAA   SBUFF3+3
474      STAA   SBUFF3+4
475      LDAA   #5
476      STAA   CHCT3+1
477      LDX    #SBUFF3+5
478      STX     INPT3
479 RBI3H  CLR    MSDO3
480 RBI3H1 LDX    #INPT3  INIT FOR INPUT
481      STX     RXPNTR  FIFO SERVICE
482      LDAA   BPS16K
483      BEQ     RBI3HA
484      LDX    #EBUFF4
485      STX     RXUVAL  INIT 16KBPS PNTRS
486      LDX    #SBUFF1
487      STX     RXLVAL
488      BRA     RBI3HB
489 RBI3HA LDX    #EBUFF3
490      STX     RXUVAL
491      LDX    #SBUFF3
492      STX     RXLVAL
493 RBI3HB LDAA   SIGACQ  SET "SIGNAL ACQ. I/O #3"
494      ORAA   #4
495      STAA   SIGACQ
496      STAA   LATCH1
497      JMP    RBIS
498 *
499 RBI4B  CMPA   #4
500      BEQ     RBI4C
501      JMP    RBIJ
502 RBI4C  LDAA   XMTRQ4  **PORT #4 BURST INIT**
503      BEQ     RBI4CA
504      JMP    TBI
505 RBI4CA LDAA   PTONRX

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506      ANDA    #8
507      BNE     RBI4D
508      JMP     TBI
509      RBI4D  ORAB   CHRAT4
510      LDAA   UT4
511      BEQ    RBI4E
512      LDAA   DATA6   CHECK FIFO'S "O.R."
513      BITA   #1
514      BNE    RBI4DA
515      LDAA   BITELT  **I/O FIFO #4 BITE**
516      ORAA   #010H
517      STAA   BITELT
518      RBI4DA CLR    UT4
519      RBI4E  LDAA   #8
520      STAA   MASKIO INIT I/O ON/OFF MASK
521      TSTB
522      BMI    RBI4G
523      LDAA   MSDO4
524      BEQ    RBI4EA
525      CLR    FLBFG4 TWO OR MORE MISSING DO'S
526      LDAA   #2
527      STAA   MSDO4
528      JMP    TBI
529      RBI4EA INCA   **FIRST MISSING DO SETUP**
530      STAA   FMSDO4
531      STAA   MSDO4
532      STAA   FILLFG  SETUP TO STUFF
533      LDAA   CHCT4   "FF" INTO BUFFER
534      LDAB   CHCT4+1
535      ADDB   #32    ADJ COUNT FOR I/O FIFO
536      ADCA   #0
537      STAA   MDOCT4
538      STAB   MDOCT4+1
539      LDAB   CHRAT4
540      BRA    RBI4H1
541      RBI4G  LDAA   MSDO4
542      CMPA   #2    TWO OR MORE MISSING DO'S?
543      BNE    RBI4H
544      LDAA   MRFTA
545      ORAA   #08H   RESET I/O FIFO #4
546      STAA   MRFTA
547      STAA   LATCH3
548      RBI4GA LDX   #SBUFF4 INIT BUFFER #4 AND
549      STX    OUTPT4 I/O FIFO #4
550      STAA   FLBFG4
551      CLRA
552      STAA   CHCT4
553      LDAA   #0FFH   **RX ELAST BUFF CH**
554      TST    BPS16K  16KBPS?
555      BEQ    RBI4GB
556      JSR    STUFF   16 KBPS ELASTIC BUFF. CHARS
557      STX    INPT4
558      LDX   #256    17 MIN ELASTIC BUFF
559      STX    CHCT4
560      LDX   #SBUFF1
561      STX    OUTPT4
562      BRA    RBI4H

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563 RBI4GB STAA SBUFF4 RCV BURST
564 STAA SBUFF4+1
565 STAA SBUFF4+2
566 STAA SBUFF4+3
567 STAA SBUFF4+4
568 LDAA #5
569 STAA CHCT4+1
570 LDX #SBUFF4+5
571 STX INPT4
572 RBI4H CLR MSDO4
573 RBI4H1 LDX #INPT4 INIT FOR INPUT
574 STX RXPNTR FIFO SERVICE
575 LDAA BPS16K
576 BEQ RBI4HA
577 LDX #EBUFF4
578 STX RXUVAL INIT 16KBPS PNTRS
579 LDX #SBUFF1
580 STX RXLVAL
581 BRA RBI4HB
582 RBI4HA LDX #EBUFF4
583 STX RXUVAL
584 LDX #SBUFF4
585 STX RXLVAL
586 RBI4HB LDAA SIGACQ SET "SIGNAL ACQ I/O #4"
587 ORAA #8
588 STAA SIGACQ
589 STAA LATCH1
590 JMP RBIS
591 ****
592 *
593 *
594 RBIJ CMPA #7 CHECK FOR SELF TEST RX BURS
595 BNE RBIJA
596 STAA SELFTR
597 LDAA #0 INIT. RX FIFO COUNT
598 LDAB #60
599 JMP RBIT
600 RBIJA LDX RCRXPT
601 CPX #ERCRX R/CCOW RX BUFFER EMPTY?
602 BEQ RBIK
603 PSHA **RCCOW/CCOW ERROR**
604 LDAA BITELT
605 ORAA #1
606 STAA BITELT
607 PULA
608 LDX #ERCRX
609 STX RCRXPT
610 RBIK LDX #SRCRX
611 CMPA #6
612 BNE RBIN
613 TSTB CCOW DO?
614 BMI RBIL
615 LDAA #0A5H OUTPUT CCOW DO
616 RBIKA STAA ACIAD ABSENT CODE TO SCU
617 JMP TBI
618 *
619 RBIL LDAA DATA1 TX REQUEST STATUS WBR

```

620	ANDA	#0FH		WBR
621	ORAA	#0C0H		WBR
622	STAA	ACIAD	SEND C CODE TO SCP	WBR
623 *				
624	LDAA	#0A1H	CCOW DO PRESENT CODE	
625 RBIM	STAA	0,X		
626	INX	RCRXPT	ADJ R/CCOW RX BUFFER PNTR	
627	STX	INPTRC		
628	STAA	SIEN		
629	JMP	TBI		
630 RBIN	TSTB		RCCOW DO?	
632 BMI	RBIO			
633 LDAA	#0A6H		RCCOW DO ABSENT CODE	
634 BRA	RBIKA			
635 RBIO	LDAA	#0A2H	RCCOW DO PRESENT CODE	
636 BRA	RBIM			
637 RBIS	BSR	BITRAT		
638 BRA	RBIT			
639 *****				
640 *				
641 *				
642 BITRAT	TST	BPS16K	TEST 16KBPS	
643 BNE	RBISF			
644 ASLB				
645 BMI	RBIU			
646 ANDB	#070H			
647 BNE	RBISA			
648 LDAB	#13		75 BPS @ 1.386 SEC	
649 CLRA			13 BYTES	
650 RTS				
651 RBISA	CMPB	#010H		
652 BNE	RBISB			
653 LDAB	#52		300 BPS @ 1.386 SEC	
654 CLRA			52 BYTES	
655 RTS				
656 RBISB	CMPB	#020H		
657 BNE	RBISC			
658 LDAB	#104		600 BPS @ 1.386 SEC	
659 CLRA			104 BYTES	
660 RTS				
661 RBISC	CMPB	#030H		
662 BNE	RBISD			
663 LDAB	#208		1200 BPS @ 1.386 SEC	
664 CLRA			208 BYTES	
665 RTS				
666 RBISD	CMPB	#040H		
667 BNE	RBISE			
668 LDAB	#0AOH		2400 BPS @ 1.386 SEC	
669 LDAA	#1		416 BYTES	
670 RTS				
671 RBISE	LDAB	#040H	4800 BPS @ 1.386 SEC	
672 LDAA	#3		832 BYTES	
673 RTS				
674 RBISF	LDAB	#0D5H	16000 BPS @ 1.386 SEC	
675 LDAA	#0AH		2773 BYTES	
676 RTS				

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677 RBIU LDAB #78      75 BPS @ 8.32 SEC
678      CLRA          78 BYTES
679      RTS
680 ****
681 *
682 *
683 RBIT STAA INCHC MSB'S OF CH. CNT.
684      STAB INCHC+1 LSB'S OF CH. CNT.
685      CLRA
686      STAA INPTRC
687      INCA
688      STAA SIEN
689 ****
690 *
691 *
692 TBI   LDAA CDRDY TEST CCOW DATA RDY FLG.
693      BEQ  TBI1
694      CLR  CDRDY
695      LDAA PA1AD
696      ORAA #020H SET DATA RDY CCOW*
697      BRA  TBI2
698 TBI1 LDAA RDRDY TEST RCCOW RDY FLG.
699      BEQ  TBI3
700      CLR  RDRDY
701      LDAA PA1AD
702      ORAA #010H SET DATA RDY RCCOW*
703 TBI2 STAA PA1AD
704      STAA PIA1AD
705 TBI3 LDAA IRSBIT IRS BITE?
706      BEQ  TBI4
707      LDAA BITELT
708      ORAA #01H
709      STAA BITELT
710 TBI4 LDAA PIA1BC CHECK TX SETUP READY
711      BMI  TBIA
712      JMP  IO1PT
713 TBIA LDAA SOEN
714      BEQ  TBIB
715      LDAB BITELT SYST OUTPUT FIFO BITE
716      ORAB #040H (TX FIFO)
717      STAB BITELT
718 *
719 ***** BEGIN TRANSMIT BURST INITIALIZATION *****
720 *
721 TBIB LDAA PIA1BD CLR LATCHED STROBE
722      LDAA DATA3 LOAD TX SETUP DATA
723      LDAB DATA5 CHECK TX INHIBIT
724      BITB #1
725      BEQ  TIBA
726      ANDA #7
727      CMPA #7
728      BEQ  TBIBA
729      JMP  IO1PT TX INHIBIT: ABORT
730 TBIBA JMP  TBIG ALLOW SELF TEST BURST
731 TIBA ANDA #047H
732      TAB
733      ANDA #7

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```

734      CMPA    #1
735      BNE     TBI2B
736      LDAA    PTONRX   IS PORT ON?
737      BITA    #1
738      BNE     TBI1BA
739      JMP     IO1PT    ABORT: PORT IS OFF
740 *
741 TBI1BA TST    BPS16K
742      BEQ     TBI1E
743      LDX     #SBUFF1  16 KBPS
744      STX     TXLVAL
745      LDX     #EBUFF4
746      STX     TXUVAL
747      BRA     TBI1EA
748 TBI1E  LDX     #SBUFF1  INIT FOR OUTPUT
749      STX     TXLVAL  FIFO SERVICE
750      LDX     #EBUFF1
751      STX     TXUVAL
752 TBI1EA LDX     #INPT1
753      STX     TXPNTR
754      CLRA
755      STAA    UT1
756      STAA    MDOCT1
757      STAA    MDOCT1+1
758      STAA    FMSDO1
759      LDAA    #2
760      STAA    MSDO1
761      LDAA    #0FEH
762      STAA    XMASK
763      LDAA    #0EFH
764      STAA    MASKR
765      LDAA    GROUP1
766      BEQ     TBI1F
767      STAA    GRP1FG
768 TBI1F  CLRA
769      STAA    GROUP1
770      ORAB    CHRAT1
771      JMP     TBIN
772 *
773 TBI2B  CMPA    #2
774      BNE     TBI3B
775      LDAA    PTONRX   IS PORT ON?
776      BITA    #2
777      BNE     TBI2BA
778      JMP     IO1PT    ABORT: PORT IS OFF
779 TBI2BA TST    BPS16K
780      BEQ     TBI2E
781      LDX     #SBUFF1  16 KBPS
782      STX     TXLVAL
783      LDX     #EBUFF4
784      STX     TXUVAL
785      BRA     TBI2EA
786 TBI2E  LDX     #SBUFF2  INIT. FOR OUTPUT
787      STX     TXLVAL  FIFO SERVICE
788      LDX     #EBUFF2
789      STX     TXUVAL
790 TBI2EA LDX     #INPT2

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```

791      STX    TXPNTR
792      CLRA
793      STAA   UT2
794      STAA   MDOCT2
795      STAA   MDOCT2+1
796      STAA   FMSDO2
797      LDAA   #2
798      STAA   MSDO2
799      LDAA   #0FDH
800      STAA   XMASK
801      LDAA   #0DFH
802      STAA   MASKR
803      LDAA   GROUP2
804      BEQ    TBI2F
805      STAA   GRP1FG
806 TBI2F  CLRA
807      STAA   GROUP2
808      ORAB   CHRAT2
809      JMP    TBIN
810 *
811 TBI3B  CMPA   #3
812      BNE    TBI4B
813      LDAA   PTONRX  IS PORT ON?
814      BITA   #4
815      BNE    TBI3BA
816      JMP    IO1PT   ABORT: PORT IS OFF
817 TBI3BA TST    BPS16K
818      BEQ    TBI3E
819      LDX    #SBUFF1  16 KBPS
820      STX    TXLVAL
821      LDX    #EBUFF4
822      STX    TXUVAL
823      BRA    TBI3EA
824 TBI3E  LDX    #SBUFF3  INIT. FOR OUPUT
825      STX    TXLVAL  FIFO SERVICE
826      LDX    #EBUFF3
827      STX    TXUVAL
828 TBI3EA LDX    #INPT3
829      STX    TXPNTR
830      CLRA
831      STAA   UT3
832      STAA   MDOCT3
833      STAA   MDOCT3+1
834      STAA   FMSDO3
835      LDAA   #2
836      STAA   MSDO3
837      LDAA   #0FBH
838      STAA   XMASK
839      LDAA   #0BFH
840      STAA   MASKR
841      LDAA   GROUP3
842      BEQ    TBI3F
843      STAA   GRP1FG
844 TBI3F  CLRA
845      STAA   GROUP3
846      ORAB   CHRAT3
847      JMP    TBIN

```

```

848 *
849 TBI4B CMPA #4
850     BNE TBIG
851     LDAA PTONRX IS PORT ON?
852     BITA #8
853     BNE TBI4BA
854     JMP IO1PT ABORT: PORT IS OFF
855 TBI4BA TST BPS16K
856     BEQ TBI4E
857     LDX #SBUFF1 16 KBPS
858     STX TXLVAL
859     LDX #EBUFF4
860     STX TXUVAL
861     BRA TBI4EA
862 TBI4E LDX #SBUFF4 INIT. FOR OUTPUT
863     STX TXLVAL FIFO SERVICE
864     LDX #EBUFF4
865     STX TXUVAL
866 TBI4EA LDX #INPT4
867     STX TXPNTR
868     CLRA
869     STAA UT4
870     STAA MDOCT4
871     STAA MDOCT4+1
872     STAA FMSDO4
873     LDAA #2
874     STAA MSDO4
875     LDAA #0F7H
876     STAA XMASK
877     LDAA #07FH
878     STAA MASKR
879     LDAA GROUP4
880     BEQ TBI4F
881     STAA GRP1FG
882 TBI4F CLRA
883     STAA GROUP4
884     ORAB CHRAT4
885     JMP TBIN
886 *
887 TBIG CMPA #7      CHECK FOR SELF TEST TX BURS
888     BNE TBIGA
889     STAA SOEN
890     STAA SELFTT
891     LDX #08000H DUMMY VALUE FOR TXPNTR
892     STX TXPNTR
893     LDX #28      SELF TEST CH CNT - 32
894     STX OUTCHC
895     LDAA #32
896     LDAB #033H      SELF TEST TX CHAR
897 TBIG1 STAB PIA1BD
898     DECA      OUTPUT 32 SELF TEST
899     BNE TBIG1      CHARS. TO TX FIFO
900     JMP RBI
901 TBIGA CMPA #6
902     BNE TBIJ
903     LDAA PA1AD IF NO DATA READY, OUTPUT
904     BITA #020H      13 BYTES OF 11001100

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905      BNE    TBIGC
906      LDAA   #0CCH    **NO CCOW DATA RDY**
907      LDX    #13
908  TBIGB  STAA   PIA1BD
909      DEX
910      BNE    TBIGB
911      BRA    TBIHB
912  TBIGC  LDX    #SCTXB
913      STX    CTXPT
914  TBIH   LDAA   0,X
915      STAA   PIA1BD  PUT CHAR IN OUTPUT FIFO
916      INX
917      CPX    #ECTXB
918      BNE    TBIH
919      LDAA   PA1AD
920      ANDA   #0DFH    CLR DATA READY CCOW
921  TBIHA  STAA   PIA1AD
922      STAA   PA1AD
923  *
924  *
925  TBIHB  ASLB
926      BMI    TBIHC
927      JMP    IO1PT
928  TBIHC  CLRA
929      STAA   PIA1BD
930      STAA   PIA1BD
931      STAA   PIA1BD
932      JMP    IO1PT
933  TBIJ   LDX    #SRTXB
934      STX    RTXPT
935  TBIK   LDAA   0,X
936      STAA   PIA1BD  PUT CHAR IN OUTPUT FIFO
937      INX
938      CPX    #ERTXB
939      BNE    TBIK
940      LDAA   PA1AD
941      ANDA   #0EFH    CLR DATA READY RCCOW
942      BRA    TBIHA
943  TBIN   JSR    BITRAT  GET TX CH. CNT.
944  TBIO   STAA   OUTCHC  MSB'S OF CH. CNT.
945      STAB   OUTCHC+1 LSB'S OF CH. CNT.
946      CLRA
947      INCA
948      STAA   SOEN
949  TBIQ   LDX    TXPNTR
950      LDAA   GRP1FG  CHECK IF FIRST GROUP
951      BEQ    TBIS
952  TBIQ1  LDAA   OUTCHC  ***COMPUTE FILL COUNT***
953      LDAB   OUTCHC+1
954      ADDB   #6     ADD ELASTIC BUFF(48 BITS)
955      ADCA   #0
956      SUBB   5,X    BURST CH CNT + ELASTIC BUFF
957      SBCA   4,X    - BUFF CH CNT = FILL COUNT
958      BCS   TBIR
959      BNE   TBIRA
960      TSTB
961      BNE   TBIRA

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962 TBIR CLR GRP1FG
963 BRA TBIS NO FILL REQUIRED
964 TBIRA STAA FILLCT
965 STAB FILLCT+1
966 LDAA 4,X NUMBER OF GOOD CHARS IN FIR
967 LDAB 5,X BURST=BUFF CH CNT - ELASTIC
968 SUBB #6 SUBT ELASTIC BUFF (48 BITS)
969 SBCA #0
970 BCC TBIRB
971 CLRA ERROR: ELASTIC BUFFER NOT
972 STAA SOEN YET FULL FOR TRANSMISSION
973 LDAA BITELT
974 ORAA #040H **TX FIFO BITE LITE ON**
975 STAA BITELT
976 BRA IO1PT
977 TBIRB STAA OUTCHC
978 STAB OUTCHC+1
979 TBIS JSR SOFAA *SERVICE OUTPUT FIFO*
980 ****
981 *
982 *
983 *
984 IO1PT LDAA PTONRX PORT #1 ON?
985 ANDA #1
986 BEQ IO1A1
987 CLR P1OFF
988 JMP IO1A
989 IO1A1 LDAA P1OFF PORT IS OFF
990 BEQ IO1A2
991 JMP IO2PT
992 IO1A2 STAA CHCT1
993 STAA CHCT1+1
994 STAA XMTRQ1
995 STAA UT1
996 LDX #0
997 STX LGDPT1
998 STAA OUFG1
999 STAA EMPTY1
1000 LDAA #2
1001 STAA MSDO1
1002 INCA
1003 STAA FLBFG1
1004 LDAA MRFTA
1005 ORAA #1 RESET FIFO I/O #1
1006 ANDA #0EFH CLR "XMT ACK"
1007 STAA MRFTA
1008 STAA LATCH3
1009 STAA P1OFF
1010 LDAA PA1AD
1011 ANDA #0FEH CLEAR "DATA RDY PORT #1"
1012 STAA PA1AD
1013 STAA PIA1AD
1014 LDX #SBUFF1
1015 STX INPT1
1016 STX OUTPT1
1017 LDAA SIGACQ CLR "SIGNAL ACQ. I/O #1"
1018 ANDA #0FEH

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```

1019      STAA    SIGACQ
1020      STAA    LATCH1
1021      LDX     TXPNTR
1022      CPX     #INPT1
1023      BNE    IO1A3
1024      CLR     SOEN
1025 IO1A3  JMP    IO2PT
1026 ****
1027 *
1028 *   INPUT SERVICE SUBROUTINE
1029 *
1030 IO1LS  LDAA    #1
1031      STAA    XFER1
1032      LDAA    IO1      OBTAIN CHAR
1033      LDX     INPT1   GET PUT PNTR
1034      STAA    0,X     PUT IT
1035      INX     INCR PUT PNTR
1036      CPX     OUTPT1 TEST OVERFLOW
1037      BNE    IO1LSX  BRANCH NO OVERFLOW
1038      LDAA    MRFTA  **OVERFLOW**
1039      ANDA   #0EFH   CLR "XMT ACK"
1040      ORAA   #1      RESET FIFO
1041      STAA    MRFTA
1042      STAA    LATCH3
1043      STAA    OUFG1   SET OUFG FLAG
1044      INS    *REMOVE RETURN
1045      INS    *
1046      JMP    IO2PT
1047 IO1LSX LDAA    BPS16K
1048      BEQ    IO1LSA
1049      CPX    #EBUFF4 16 KBPS
1050      BNE    IO1LSB
1051      LDX    #SBUFF1
1052      BRA    IO1LSB
1053 IO1LSA CPX    #EBUFF1 TEST END OF INPUT
1054      BNE    IO1LSB NO
1055      LDX    #SBUFF1 GET INITIAL VALUE
1056 IO1LSB STX    INPT1
1057      LDX    CHCT1   GET CHAR COUNT
1058      INX    INCX COUNT
1059      STX    CHCT1   PUT BACK
1060      RTS
1061 ****
1062 *
1063 *LOAD I/O #1 FIFO WITH 1 CHAR. ROUTINE
1064 *
1065 IO1LF  LDX    OUTPT1
1066      LDAA    RXINHB
1067      BITA   #1      IS THE EXTEND TRANSMIT FLAG SET? WBR
1068      BNE    IO1LF1 YES:RX NOT ALLOWED WBR
1069      LDAA    0,X
1070      STAA    IO1+2   OUTPUT CH. TO I/O #1 FIFO
1071 IO1LF1 INX
1072      LDAB    BPS16K
1073      BEQ    IO1LFA
1074      CPX    #EBUFF4 16 KBPS
1075      BNE    IO1LFB

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1076      LDX      #SBUFF1
1077      BRA      IO1LFB
1078  IO1LFA CPX      #EBUFF1
1079      BNE      IO1LFB
1080      LDX      #SBUFF1
1081  IO1LFB STX      OUTPT1
1082      LDAA     #1
1083      STAA      XFER1
1084      LDAA      FMSDO1    TEST MISSING DO
1085      BEQ      IO1LFC
1086      LDX      MDOCT1
1087      DEX
1088      STX      MDOCT1
1089      BNE      IO1LFC
1090      LDAA      SIGACQ
1091      ANDA     #0FEH
1092      STAA      SIGACQ
1093      STAA      LATCH1
1094      CLR       FMSDO1
1095  IO1LFC LDX      CHCT1    ADJUST CHAR COUNT
1096      DEX
1097      STX      CHCT1
1098      BNE      IO1LFD
1099      INS       REMOVE RETURN
1100      INS
1101      JMP      IO1YE1    GO CHECK UNDERFLOW
1102  IO1LFD RTS
1103 ****
1104 *
1105 *LOAD I/O #1 FIFO WITH 3 BUF. CH. ROUTINE
1106 *
1107 LD1      LDX      OUTPT1
1108      LDAA     0,X
1109      STAA      IO1+2
1110      LDAA     1,X
1111      STAA      IO1+2
1112      LDAA     2,X
1113      STAA      IO1+2
1114      INX
1115      INX
1116      INX
1117      STX      OUTPT1
1118      LDX      CHCT1
1119      DEX
1120      DEX
1121      DEX
1122      STX      CHCT1
1123      RTS
1124 ****
1125 *
1126 ***** BEGIN SERVICING I/O PORT #1 *****
1127 *
1128 IO1A     LDAA      PTONRX    RX ONLY?
1129      BITA     #010H
1130      BEQ      IO1AA
1131      JMP      IO1Y
1132 IO1AA    LDAA      DATA1

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1133      BITA    #1
1134      BNE     IO1B
1135      JMP     IO1Y
1136  IO1B  ASLA
1137      BPL     IO1C
1138      LDAA    XMTRQ1
1139      BNE     IO1C
1140      LDAA    EMPTY1
1141      BNE     IO1CA
1142      LDX     CHCT1    R/T SELECTED: CHECK RCV DON
1143      BEQ     IO1BB
1144  IO1BA  JMP     IO1YD
1145  IO1BB  LDAA    DATA6    TEST: I/O FIFO UNDERFLOW
1146      BITA    #8
1147      BNE     IO1BA    BRANCH: NO UNDERFLOW
1148  IO1C   LDAA    XMTRQ1
1149      BNE     IO1D
1150      LDAA    EMPTY1
1151      BEQ     IO1E
1152  IO1CA  CLR     EMPTY1    GET HERE W/MULTIPLE
1153      STAA    XMTRQ1    TX REQ PER FRAME
1154      LDX     #0
1155      STX     LGDPT1
1156      LDAA    MRFTA
1157      ORAA    #010H    SET "TX ACK"
1158      STAA    MRFTA
1159      STAA    LATCH3
1160  IO1D   LDAA    OUFG1
1161      BEQ     IO1H
1162      STAA    XFER1
1163      JMP     IO2PT
1164  IO1E   LDAA    DATA5    CHECK TX INHIBIT
1165      ANDA    #1
1166      BEQ     IO1F
1167      JMP     IO2PT
1168  IO1F   LDAA    #1    **INIT FOR PORT #1**
1169      STAA    XMTRQ1    **DATA TRANSMISSION**
1170      STAA    GROUP1
1171      STAA    XFER1
1172      STAA    FLBFG1
1173      LDAA    SIGACQ
1174      ORAA    #010H    SELECT I/O INPUT MODE
1175      ANDA    #0FEH    CLR "SIG. ACQ. #1"
1176      STAA    SIGACQ
1177      STAA    LATCH1
1178      LDAA    MRFTA
1179      ORAA    #1    TOGGLE FIFO'S RESET
1180      STAA    LATCH3
1181      CLR     IO1+2    CLR PIA B-SIDE
1182      ANDA    #0FEH
1183      ORAA    #010H    SET "XMT ACK" I/O #1
1184      STAA    MRFTA
1185      STAA    LATCH3
1186      LDX     #SBUFF1+6
1187      STX     INPT1
1188      LDX     #SBUFF1
1189      STX     OUTPT1

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1190      LDAA    #0FFH      STUFF 6 ELASTIC
1191      STAA    0,X       BUFFER CHARACTERS (CC)
1192      STAA    1,X
1193      STAA    2,X
1194      STAA    3,X
1195      STAA    4,X
1196      STAA    5,X
1197      LDX     #6
1198      STX     CHCT1
1199      JMP     IO2PT
1200 IO1G   LDX     #SBUFF1
1201      STX     INPT1
1202      STX     OUTPT1
1203      LDX     #0
1204      STX     CHCT1
1205      LDAA    SIGACQ    CLR "SIGNAL ACQ. I/O #1
1206      ANDA    #0FEH
1207      STAA    SIGACQ
1208      STAA    LATCH1
1209      JMP     IO2PT
1210 IO1H   LDAA    DATA5     CHECK TX INHIBIT
1211      ANDA    #1
1212      BEQ     IO1HA
1213      JMP     IO1YA1
1214 IO1HA  LDAB    FLBFG1
1215      BEQ     IO1HB
1216      JMP     IO1O
1217 IO1HB  LDAA    DATA6     TEST FIFO "O.R."
1218      BITA    #8
1219      BNE     IO1I
1220      JMP     IO1XP
1221 IO1I   JSR     IO1LS    LOAD & STORE 1 CHAR
1222      LDAA    DATA6
1223      BITA    #8
1224      BNE     IO1K
1225      JMP     IO1XP
1226 IO1K   JSR     IO1LS    LOAD & STORE 2 CHAR
1227      LDAA    DATA6
1228      BITA    #8
1229      BNE     IO1M
1230      JMP     IO1XP
1231 IO1M   JSR     IO1LS    LOAD & STORE 3 CHAR
1232      LDAA    DATA6
1233      BITA    #8
1234      BNE     IO1N2
1235      JMP     IO1XP
1236 IO1N2  JSR     IO1LS    LOAD & STORE 4 CHAR
1237      LDAA    BPS16K
1238      BNE     IO1N3
1239      JMP     IO1XP
1240 IO1N3  LDAA    DATA6    *16KBPS: ALLOW MORE*
1241      BITA    #8      *I/O SERVICING*
1242      BNE     IO1N4
1243      JMP     IO1XP
1244 IO1N4  JSR     IO1LS    LOAD & STORE 5 CHAR.
1245      LDAA    DATA6
1246      BITA    #8

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1247	BNE	IO1N5	
1248	JMP	IO1XP	
1249	IO1N5	JSR	IO1LS LOAD & STORE 6 CHAR.
1250	LDAA	DATA6	
1251	BITA	#8	
1252	BNE	IO1N6	
1253	JMP	IO1XP	
1254	IO1N6	JSR	IO1LS LOAD & STORE 7 CHAR.
1255	LDAA	DATA6	
1256	BITA	#8	
1257	BNE	IO1N7	
1258	JMP	IO1XP	
1259	IO1N7	JSR	IO1LS LOAD & STORE 8 CHAR.
1260	LDAA	DATA6	
1261	BITA	#8	
1262	BNE	IO1N8	
1263	JMP	IO1XP	
1264	IO1N8	JSR	IO1LS LOAD & STORE 9 CHAR.
1265	LDAA	DATA6	
1266	BITA	#8	
1267	BNE	IO1N9	
1268	JMP	IO1XP	
1269	IO1N9	JSR	IO1LS LOAD & STORE 10 CHAR.
1270	LDAA	DATA6	
1271	BITA	#8	
1272	BNE	IO1N10	
1273	JMP	IO1XP	
1274	IO1N10	JSR	IO1LS LOAD & STORE 11 CHAR.
1275	JMP	IO1XP	
1276	IO1O	LDAA	DATA6
1277	BITA	#8	
1278	BEQ	IO1XP	
1279	IO1P	CLR	FLBFG1
1280	LDAA	PA1AD	SET "DATA RDY PORT #1"
1281	ORAA	#1	
1282	STAA	PA1AD	
1283	STAA	PIA1AD	
1284	JMP	IO1I	
1285	IO1XP	LDAA	EMPTY1 **TEST IF SETUP**
1286		BPL	IO1XQ **LAST GOOD DATA PNTR**
1287		LDX	INPT1 DO SETUP
1288		STX	LGDPT1
1289		LDAA	#1
1290		STAA	EMPTY1
1291	IO1XQ	JMP	IO2PT
1292	IO1Y	LDAA	XMTRQ1
1293		BEQ	IO1YB
1294		LDAA	MRFIA
1295		ANDA	#0EFH CLEAR "TX ACK"
1296		STAA	MRFIA
1297		STAA	LATCH3
1298		CLR	XMTRQ1 FIRST TIME THAT
1299		LDAA	#0FFH TX REQ = FALSE
1300		STAA	EMPTY1
1301		LDAA	PA1AD
1302		ANDA	#1
1303		BNE	IO1YA

1304	STAA	CHCT1	NO DATA: ABORT INPUT
1305	STAA	CHCT1+1	
1306	STAA	EMPTY1	
1307	INCA		
1308	STAA	FLBFG1	
1309	LDAA	MRFTA	
1310	ORAA	#1	
1311	STAA	MRFTA	
1312	STAA	LATCH3	
1313	JMP	IO2PT	
1314	IO1YA	JMP	IO1D
1315	IO1YB	LDAA	EMPTY1
1316	BNE	IO1YA	
1317	JMP	IO1YD	
1318	IO1YA1	CLRA	
1319	STAA	XMTRQ1	
1320	STAA	EMPTY1	
1321	LDAA	PA1AD	
1322	ANDA	#0FEH	
1323	STAA	PIA1AD	CLEAR "DATA RDY PORT #1"
1324	STAA	PA1AD	
1325	LDAA	MRFTA	
1326	ORAA	#1	RESET I/O #1 FIFO
1327	ANDA	#0EFH	CLR TX ACK I/O #1
1328	STAA	MRFTA	
1329	STAA	LATCH3	
1330	IO1YC	LDAA	MRFTA **INIT I/O PORT **
1331	ORAA	#1	**TO OUTPUT**
1332	STAA	MRFTA	**RX BURST DATA**
1333	STAA	LATCH3	RESET I/O #1 FIFO
1334	LDAA	SIGACQ	
1335	ANDA	#0EFH	SELECT I/O OUTPUT MODE
1336	STAA	SIGACQ	
1337	STAA	LATCH1	
1338	IO1YC1	CLR	FMSDO1
1339	LDAA	#2	
1340	STAA	MSDO1	
1341	STAA	FLBFG1	
1342	JMP	IO1G	
1343	IO1YD	LDAA	FLBFG1
1344	BEQ	IO1YF	
1345	STAA	XFER1	
1346	LDAA	CHCT1+1	
1347	CMPA	#10	RCV ELASTIC BUFFER FULL?
1348	BGE	IO1YE	
1349	JMP	IO2PT	
1350	IO1YE	CLR	FLBFG1
1351	STAA	UT1	
1352	LDAA	SIGACQ	SET OUTPUT MODE
1353	ANDA	#0EFH	
1354	STAA	SIGACQ	
1355	STAA	LATCH1	
1356	LDAA	MRFTA	
1357	ANDA	#0FEH	CLR RESET ON I/O FIFO
1358	STAA	MRFTA	
1359	STAA	LATCH3	
1360	JSR	LD1	

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1361      JSR     LD1      LOAD FIFO W/6 BUF. CH.
1362      LDAA    BPS16K
1363      BEQ     IO1YE0
1364      JSR     LD1      16KBPS SO:
1365      JSR     LD1
1366      JSR     LD1
1367      JSR     LD1
1368      JSR     LD1      LOAD FIFO WITH 21 BUF. CH.
1369 IO1YE0 JMP    IO2PT
1370 IO1YE1 LDAA  #1
1371      STAA   XFER1
1372      LDAA   UT1
1373      BNE    IO1YE0
1374      LDAA   DATA6      CHECK FIFO UNDERFLOW
1375      BITA   #8      BY TESTING FIFO "O.R."
1376      BEQ    IO1YC1 **UNDERFLOW**
1377      JMP    IO2PT
1378 IO1YF  LDX    CHCT1
1379      BEQ    IO1YE1
1380      LDAA   DATA6
1381      LDAB   UT1
1382      BNE    IO1YFA
1383      BITA   #8
1384      BEQ    IO1YC1
1385 IO1YFA BITA  #080H      CHECK FIFO "I.R.": FULL?
1386      BEQ    IO2PT
1387 IO1YG  JSR    IO1LF      OUTPUT 1 CH. TO FIFO
1388      LDAA   DATA6
1389      BITA   #080H      CHECK "I.R.": FULL?
1390      BEQ    IO2PT
1391 IO1YH  JSR    IO1LF      OUTPUT 2 CH. TO FIFO
1392      LDAA   DATA6
1393      BITA   #080H      CHECK "I.R.": FULL?
1394      BEQ    IO2PT
1395 IO1YI  JSR    IO1LF      OUTPUT 3 CH. TO FIFO
1396      LDAA   BPS16K
1397      BEQ    IO2PT
1398 IO1YJ  LDAA   DATA6      16KBPS: SERVICE 10 CHARS.
1399      BITA   #080H      CHECK "I.R.": FULL?
1400      BEQ    IO2PT
1401 IO1YK  JSR    IO1LF      OUTPUT 4 CH. TO FIFO
1402      LDAA   DATA6
1403      BITA   #080H      CHECK "I.R.": FULL?
1404      BEQ    IO2PT
1405 IO1YL  JSR    IO1LF      OUTPUT 5 CH. TO FIFO
1406      LDAA   DATA6
1407      BITA   #080H      CHECK "I.R.": FULL?
1408      BEQ    IO2PT
1409 IO1YM  JSR    IO1LF      OUTPUT 6 CH. TO FIFO
1410      LDAA   DATA6
1411      BITA   #080H      CHECK "I.R.": FULL?
1412      BEQ    IO2PT
1413 IO1YN  JSR    IO1LF      OUTPUT 7 CH. TO FIFO
1414      LDAA   DATA6
1415      BITA   #080H      CHECK "I.R.": FULL?
1416      BEQ    IO2PT
1417 IO1YO  JSR    IO1LF      OUTPUT 8 CH. TO FIFO

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1418      LDAA    DATA6
1419      BITA    #080H      CHECK "I.R.": FULL?
1420      BEQ     IO2PT
1421 IO1YP   JSR     IO1LF      OUTPUT 9 CH. TO FIFO
1422      LDAA    DATA6
1423      BITA    #080H      CHECK "I.R.": FULL?
1424      BEQ     IO2PT
1425 IO1YQ   JSR     IO1LF      OUTPUT 10 CH. TO FIFO
1426 ****
1427 *
1428 *
1429 *
1430 IO2PT   LDAA    PTONRX    PORT #2 ON?
1431      ANDA    #2
1432      BEQ     IO2A1
1433      CLR     P2OFF
1434      JMP     IO2A
1435 IO2A1   LDAA    P2OFF      PORT IS OFF
1436      BEQ     IO2A2
1437      JMP     IO3PT
1438 IO2A2   STAA    CHCT2
1439      STAA    CHCT2+1
1440      STAA    XMTRQ2
1441      STAA    UT2
1442      LDX     #0
1443      STX     LGDPT2
1444      STAA    OUFG2
1445      STAA    EMPTY2
1446      LDAA    #2
1447      STAA    MSDO2
1448      INCA
1449      STAA    FLBFG2
1450      LDAA    MRFTA
1451      ORAA    #2      RESET FIFO I/O #2
1452      ANDA    #0DFH
1453      STAA    MRFTA
1454      STAA    LATCH3
1455      STAA    P2OFF
1456      LDAA    PA1AD
1457      ANDA    #0FDH      CLEAR "DATA RDY PORT #2"
1458      STAA    PA1AD
1459      STAA    PIA1AD
1460      LDX     #SBUFF2
1461      STX     INPT2
1462      STX     OUTPT2
1463      LDAA    SIGACQ      CLR "SIGNAL ACQ. I/O #2"
1464      ANDA    #0FDH
1465      STAA    SIGACQ
1466      STAA    LATCH1
1467      LDX     TXPNTR
1468      CPX     #INPT2
1469      BNE     IO2A3
1470      CLR     SOEN
1471 IO2A3   JMP     IO3PT
1472 ****
1473 *
1474 *      INPUT SERVICE ROUTINE

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```

1475 *
1476 IO2LS LDAA #1
1477 STAA XFER2
1478 LDAA IO2 OBTAIN CHAR
1479 LDX INPT2 GET PUT PNTR
1480 STAA 0,X PUT IT
1481 INX INCR PUT PNTR
1482 CPX OUTPT2 TEST OVERFLOW
1483 BNE IO2LSX BRANCH NO OVERFLOW
1484 LDAA MRFTA **OVERFLOW**
1485 ANDA #0DFH CLR "XMT ACK"
1486 ORAA #2 RESET FIFO
1487 STAA MRFTA
1488 STAA LATCH3
1489 STAA OUFG2 SET OUFG FLAG
1490 INS *REMOVE RETURN
1491 INS *
1492 JMP IO3PT
1493 IO2LSX LDAA BPS16K
1494 BEQ IO2LSA
1495 CPX #EBUFF4 16 KBPS
1496 BNE IO2LSB
1497 LDX #SBUFF1
1498 BRA IO2LSB
1499 IO2LSA CPX #EBUFF2 TEST END OF INPUT
1500 BNE IO2LSB NO
1501 LDX #SBUFF2 GET INITIAL VALUE
1502 IO2LSB STX INPT2
1503 LDX CHCT2 GET CHAR COUNT
1504 INX INCR COUNT
1505 STX CHCT2 PUT BACK
1506 RTS
1507 ****
1508 *
1509 *LOAD I/O #2 FIFO WITH 1 CHAR ROUTINE
1510 *
1511 IO2LF LDX OUTPT2
1512 LDAA RXINHB WBR
1513 BITA #2 IS THE EXTEND TRANSMIT FLAG SET? WBR
1514 BNE IO2LF1 YES:RX NOT ALLOWED WBR
1515 LDAA 0,X
1516 STAA IO2+2 OUTPUT CH. TO I/O #2 FIFO
1517 IO2LF1 INX ADJ. OUTPUT PNTR.
1518 LDAB BPS16K
1519 BEQ IO2LFA
1520 CPX #EBUFF4 16 KBPS
1521 BNE IO2LFB
1522 LDX #SBUFF1
1523 BRA IO2LFB
1524 IO2LFA CPX #EBUFF2
1525 BNE IO2LFB
1526 LDX #SBUFF2
1527 IO2LFB STX OUTPT2
1528 LDAA #1
1529 STAA XFER2
1530 LDAA FMSDO2 TEST MISSING DO
1531 BEQ IO2LFC

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1532      LDX      MDOCT2
1533      DEX
1534      STX      MDOCT2
1535      BNE      IO2LFC
1536      LDAA     SIGACQ
1537      ANDA     #0FDH
1538      STAA     SIGACQ
1539      STAA     LATCH1
1540      CLR      FMSDO2
1541 IO2LFC LDX      CHCT2      ADJUST CHAR COUNT
1542      DEX
1543      STX      CHCT2
1544      BNE      IO2LFD
1545      INS      REMOVE RETURN
1546      INS
1547      JMP      IO2YE1    GO CHECK UNDERFLOW
1548 IO2LFD RTS
1549 ****
1550 *
1551 * LOAD FIFO I/O #2 WITH 3 BUF. CH. ROUTINE
1552 *
1553 LD2      LDX      OUTPT2
1554      LDAA     0,X
1555      STAA     IO2+2
1556      LDAA     1,X
1557      STAA     IO2+2
1558      LDAA     2,X
1559      STAA     IO2+2
1560      INX
1561      INX
1562      INX
1563      STX      OUTPT2
1564      LDX      CHCT2
1565      DEX
1566      DEX
1567      DEX
1568      STX      CHCT2
1569      RTS
1570 ****
1571 *
1572 ***** BEGIN SERVICING I/O PORT #2 *****
```

1573 *

```

1574 IO2A    LDAA     PTONRX    RX ONLY?
1575      BITA     #020H
1576      BEQ      IO2AA
1577      JMP      IO2Y
1578 IO2AA   LDAA     DATA1
1579      BITA     #2
1580      BNE      IO2B
1581      JMP      IO2Y
1582 IO2B    ASLA
1583      BPL      IO2C
1584      LDAA     XMTRQ2
1585      BNE      IO2C
1586      LDAA     EMPTY2
1587      BNE      IO2CA
1588      LDX      CHCT2    R/T SELECTED: CHECK RCV DON
```

1589	BEQ	IO2BB	
1590	IO2BA	JMP	IO2YD
1591	IO2BB	LDAA	DATA6 TEST: I/O FIFO UNDERFLOW
1592		BITA	#4
1593		BNE	IO2BA BRANCH: NO UNDERFLOW
1594	IO2C	LDAA	XMTRQ2
1595		BNE	IO2D
1596		LDAA	EMPTY2
1597		BEQ	IO2E
1598	IO2CA	CLR	EMPTY2 GET HERE W/MULTIPLE
1599		STAA	XMTRQ2 TX REQ PER FRAME
1600		LDX	#0
1601		STX	LGDPT2
1602		LDAA	MRFTA
1603		ORAA	#020H SET "TX ACK"
1604		STAA	MRFTA
1605		STAA	LATCH3
1606	IO2D	LDAA	OUFG2
1607		BNE	IO2DA
1608		JMP	IO2H
1609	IO2DA	STAA	XFER2
1610		JMP	IO3PT
1611	IO2E	LDAA	DATA5 CHECK TX INHIBIT
1612		ANDA	#1
1613		BEQ	IO2F
1614		JMP	IO3PT
1615	IO2F	LDAA	#1 **INIT FOR PORT #2**
1616		STAA	XMTRQ2 **DATA TRANSMISSION**
1617		STAA	GROUP2
1618		STAA	XFER2
1619		STAA	FLBFG2
1620		LDAA	SIGACQ
1621		ORAA	#020H SELECT I/O INPUT MODE
1622		ANDA	#0FDH CLR "SIG. ACQ. #2"
1623		STAA	SIGACQ
1624		STAA	LATCH1
1625		LDAA	MRFTA
1626		ORAA	#2 TOGGLE FIFO'S RESET
1627		STAA	LATCH3
1628		CLR	IO2+2 CLR PIA B-SIDE
1629		ANDA	#0FDH
1630		ORAA	#020H SET "XMT ACK" I/O #2
1631		STAA	MRFTA
1632		STAA	LATCH3
1633		LDAA	BPS16K
1634		BEQ	IO2FA
1635		LDX	#SBUFF1+6 16KBPS
1636		STX	INPT2
1637		LDX	#SBUFF1
1638		BRA	IO2FB
1639	IO2FA	LDX	#SBUFF2+6
1640		STX	INPT2
1641		LDX	#SBUFF2
1642	IO2FB	STX	OUTPT2
1643		LDAA	#0FFH STUFF 6 ELASTIC
1644		STAA	0,X BUFFER CHARACTERS (CC)
1645		STAA	1,X

1646	STAA	2,X
1647	STAA	3,X
1648	STAA	4,X
1649	STAA	5,X
1650	LDX	#6
1651	STX	CHCT2
1652	JMP	IO3PT
1653 IO2G	LDAA	BPS16K
1654	BEQ	IO2GA
1655	LDX	#\$BUFF1 16KBPS
1656	BRA	IO2GB
1657 IO2GA	LDX	#\$BUFF2
1658 IO2GB	STX	INPT2
1659	STX	OUTPT2
1660	LDX	#0
1661	STX	CHCT2
1662	LDAA	SIGACQ CLR "SIGNAL ACQ. I/O #2"
1663	ANDA	#0FDH
1664	STAA	SIGACQ
1665	STAA	LATCH1
1666	JMP	IO3PT
1667 IO2H	LDAA	DATA5 CHECK TX INHIBIT
1668	ANDA	#1
1669	BEQ	IO2HA
1670	JMP	IO2YA1
1671 IO2HA	LDAB	FLBFG2
1672	BEQ	IO2HB
1673	JMP	IO2O
1674 IO2HB	LDAA	DATA6 TEST FIFO "O.R."
1675	BITA	#4
1676	BNE	IO2I
1677	JMP	IO2XP
1678 IO2I	JSR	IO2LS LOAD & STORE 1 CHAR
1679	LDAA	DATA6
1680	BITA	#4
1681	BNE	IO2K
1682	JMP	IO2XP
1683 IO2K	JSR	IO2LS LOAD & STORE 2 CHAR
1684	LDAA	DATA6
1685	BITA	#4
1686	BNE	IO2M
1687	JMP	IO2XP
1688 IO2M	JSR	IO2LS LOAD & STORE 3 CHAR
1689	LDAA	DATA6
1690	BITA	#4
1691	BNE	IO2N2
1692	JMP	IO2XP
1693 IO2N2	JSR	IO2LS LOAD & STORE 4 CHAR
1694	LDAA	BPS16K
1695	BNE	IO2N3
1696	JMP	IO2XP
1697 IO2N3	LDAA	DATA6 *16KBPS: ALLOW MORE*
1698	BITA	#4 *I/O SERVICING*
1699	BNE	IO2N4
1700	JMP	IO2XP
1701 IO2N4	JSR	IO2LS LOAD & STORE 5 CHAR.
1702	LDAA	DATA6

1703	BITA	#4	
1704	BNE	IO2N5	
1705	JMP	IO2XP	
1706	IO2N5	JSR IO2LS	LOAD & STORE 6 CHAR.
1707	LDAA	DATA6	
1708	BITA	#4	
1709	BNE	IO2N6	
1710	JMP	IO2XP	
1711	IO2N6	JSR IO2LS	LOAD & STORE 7 CHAR.
1712	LDAA	DATA6	
1713	BITA	#4	
1714	BNE	IO2N7	
1715	JMP	IO2XP	
1716	IO2N7	JSR IO2LS	LOAD & STORE 8 CHAR.
1717	LDAA	DATA6	
1718	BITA	#4	
1719	BNE	IO2N8	
1720	JMP	IO2XP	
1721	IO2N8	JSR IO2LS	LOAD & STORE 9 CHAR.
1722	LDAA	DATA6	
1723	BITA	#4	
1724	BNE	IO2N9	
1725	JMP	IO2XP	
1726	IO2N9	JSR IO2LS	LOAD & STORE 10 CHAR.
1727	LDAA	DATA6	
1728	BITA	#4	
1729	BNE	IO2N10	
1730	JMP	IO2XP	
1731	IO2N10	JSR IO2LS	LOAD & STORE 11 CHAR.
1732	JMP	IO2XP	
1733	IO2O	LDAA DATA6	
1734	BITA	#4	
1735	BEQ	IO2XP	
1736	IO2P	CLR FLBFG2	
1737	LDAA	PA1AD	SET "DATA RDY PORT #2"
1738	ORAA	#2	
1739	STAA	PA1AD	
1740	STAA	PIA1AD	
1741	JMP	IO2I	
1742	IO2XP	LDAA EMPTYY2	**TEST IF SETUP**
1743	BPL	IO2XQ	**LAST GOOD DATA PNTR**
1744	LDX	INPT2	DO SETUP
1745	STX	LGDPT2	
1746	LDAA	#1	
1747	STAA	EMPTY2	
1748	IO2XQ	JMP IO3PT	
1749	IO2Y	LDAA XMTRQ2	
1750	BEQ	IO2YB	
1751	LDAA	MRFTA	
1752	ANDA	#0DFH	CLR "TX ACK"
1753	STAA	MRFTA	
1754	STAA	LATCH3	
1755	CLR	XMTRQ2	FIRST TIME THAT
1756	LDAA	#0FFH	TX REQ = FALSE
1757	STAA	EMPTY2	
1758	LDAA	PA1AD	
1759	ANDA	#2	

1760	BNE	IO2YA	
1761	STAA	CHCT2	NO DATA: ABORT INPUT
1762	STAA	CHCT2+1	
1763	STAA	EMPTY2	
1764	INCA		
1765	STAA	FLBFG2	
1766	LDAA	MRFTA	
1767	ORAA	#2	
1768	STAA	MRFTA	
1769	STAA	LATCH3	
1770	JMP	IO3PT	
1771	IO2YA	JMP	IO2D
1772	IO2YB	LDAA	EMPTY2
1773	BNE	IO2YA	
1774	JMP	IO2YD	
1775	IO2YA1	CLRA	
1776	STAA	XMTRQ2	
1777	STAA	EMPTY2	
1778	LDAA	PA1AD	
1779	ANDA	#0FDH	
1780	STAA	PIA1AD	CLEAR "DATA RDY PORT #2"
1781	STAA	PA1AD	
1782	LDAA	MRFTA	
1783	ORAA	#2	RESET I/O #2 FIFO
1784	ANDA	#0DFH	CLR TX ACK I/O #2
1785	STAA	MRFTA	
1786	STAA	LATCH3	
1787	IO2YC	LDAA	MRFTA **INIT I/O PORT**
1788	ORAA	#2	**TO OUTPUT**
1789	STAA	MRFTA	**RX BURST DATA**
1790	STAA	LATCH3	RESET I/O #2 FIFO
1791	LDAA	SIGACQ	
1792	ANDA	#0DFH	SELECT I/O OUTPUT MODE
1793	STAA	SIGACQ	
1794	STAA	LATCH1	
1795	IO2YC1	CLR	FMSDO2
1796	LDAA	#2	
1797	STAA	MSDO2	
1798	STAA	FLBFG2	
1799	JMP	IO2G	
1800	IO2YD	LDAA	FLBFG2
1801	BEQ	IO2YF	
1802	STAA	XFER2	
1803	LDAA	CHCT2+1	
1804	CMPA	#10	RCV ELASTIC BUFFER FULL?
1805	BGE	IO2YE	
1806	JMP	IO3PT	
1807	IO2YE	CLR	FLBFG2
1808	STAA	UT2	
1809	LDAA	SIGACQ	SET OUTPUT MODE
1810	ANDA	#0DFH	
1811	STAA	SIGACQ	
1812	STAA	LATCH1	
1813	LDAA	MRFTA	
1814	ANDA	#0FDH	CLR REST ON I/O FIFO
1815	STAA	MRFTA	
1816	STAA	LATCH3	

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1817      JSR     LD2
1818      JSR     LD2      LOAD FIFO W/6 BUF. CH.
1819      LDAA    BPS16K
1820      BEQ    IO2YE0
1821      JSR     LD2      16 KBPS SO:
1822      JSR     LD2
1823      JSR     LD2
1824      JSR     LD2
1825      JSR     LD2      LOAD FIFO W/21 BUF. CH.
1826 IO2YE0 JMP    IO3PT
1827 IO2YE1 LDAA    #1
1828      STAA    XFER2
1829      LDAA    UT2
1830      BNE    IO2YE0
1831      LDAA    DATA6      CHECK FIFO UNDERFLOW
1832      BITA    #4      BY TESTING FIFO "O.R."
1833      BEQ    IO2YC1      **UNDERFLOW**
1834      JMP    IO3PT
1835 IO2YF  LDX    CHCT2
1836      BEQ    IO2YE1
1837      LDAA    DATA6
1838      LDAB    UT2
1839      BNE    IO2YFA
1840      BITA    #4
1841      BEQ    IO2YC1
1842 IO2YFA BITA    #040H      CHECK FIFO "I.R.": FULL?
1843      BEQ    IO3PT
1844 IO2YG  JSR    IO2LF      OUTPUT 1 CH. TO FIFO
1845      LDAA    DATA6
1846      BITA    #040H      CHECK "I.R.": FULL?
1847      BEQ    IO3PT
1848 IO2YH  JSR    IO2LF      OUTPUT 2 CH. TO FIFO
1849      LDAA    DATA6
1850      BITA    #040H      CHECK "I.R.": FULL?
1851      BEQ    IO3PT
1852 IO2YI  JSR    IO2LF      OUTPUT 3 CH. TO FIFO
1853      LDAA    BPS16K
1854      BEQ    IO3PT
1855 IO2YJ  LDAA    DATA6      16 KBPS: SERVICE 10 CHARS.
1856      BITA    #040H      CHECK "I.R.": FULL?
1857      BEQ    IO3PT
1858 IO2YK  JSR    IO2LF      OUTPUT 4 CH. TO FIFO
1859      LDAA    DATA6
1860      BITA    #040H      CHECK "I.R.": FULL?
1861      BEQ    IO3PT
1862 IO2YL  JSR    IO2LF      OUTPUT 5 CH. TO FIFO
1863      LDAA    DATA6
1864      BITA    #040H      CHECK "I.R.": FULL?
1865      BEQ    IO3PT
1866 IO2YM  JSR    IO2LF      OUTPUT 6 CH. TO FIFO
1867      LDAA    DATA6
1868      BITA    #040H      CHECK "I.R.": FULL?
1869      BEQ    IO3PT
1870 IO2YN  JSR    IO2LF      OUTPUT 7 CH. TO FIFO
1871      LDAA    DATA6
1872      BITA    #040H      CHECK "I.R.": FULL?
1873      BEQ    IO3PT

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1874 IO2YO JSR IO2LF OUTPUT 8 CH. TO FIFO
1875 LDAA DATA6
1876 BITA #040H CHECK "I.R.": FULL?
1877 BEQ IO3PT
1878 IO2YP JSR IO2LF OUTPUT 9 CH. TO FIFO
1879 LDAA DATA6
1880 BITA #040H CHECK "I.R.": FULL?
1881 BEQ IO3PT
1882 IO2YQ JSR IO2LF OUTPUT 10 CH. TO FIFO
1883 ****
1884 *
1885 *
1886 *
1887 IO3PT LDAA PTONRX PORT #3 ON?
1888 ANDA #4
1889 BEQ IO3A1
1890 CLR P3OFF
1891 JMP IO3A
1892 IO3A1 LDAA P3OFF PORT IS OFF
1893 BEQ IO3A2
1894 JMP IO4PT
1895 IO3A2 STAA CHCT3
1896 STAA CHCT3+1
1897 STAA XMTRQ3
1898 STAA UT3
1899 LDX #0
1900 STX LGDPT3
1901 STAA OUFG3
1902 STAA EMPTY3
1903 LDAA #2
1904 STAA MSDO3
1905 INCA
1906 STAA FLBFG3
1907 LDAA MRFTA
1908 ORAA #4 RESET FIFO I/O #3
1909 ANDA #0BFH CLR XMT ACK I/O #3
1910 STAA MRFTA
1911 STAA LATCH3
1912 STAA P3OFF
1913 LDAA PA1AD
1914 ANDA #0FBH CLEAR "DATA RDY PORT #3"
1915 STAA PA1AD
1916 STAA PIA1AD
1917 LDX #SBUFF3
1918 STX INPT3
1919 STX OUTPT3
1920 LDAA SIGACQ CLR "SIGNAL ACQ. I/O #3"
1921 ANDA #0FBH
1922 STAA SIGACQ
1923 STAA LATCH1
1924 LDX TXPNTR
1925 CPX #INPT3
1926 BNE IO3A3
1927 CLR SOEN
1928 IO3A3 JMP IO4PT
1929 ****
1930 *

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```

1931 * INPUT SERVICE SUBROUTINE
1932 *
1933 IO3LS LDAA #1
1934 STAA XFER3
1935 LDAA IO3      OBTAIN CHAR
1936 LDX INPT3   GET PUT PNTR
1937 STAA 0,X     PUT IT
1938 INX          INCR PUT PNTR
1939 CPX OUTPT3  TEST OVERFLOW
1940 BNE IO3LSX  BRANCH NO OVERFLOW
1941 LDAA MRFIA  **OVERFLOW**
1942 ANDA #0BFH  CLR XMT ACK I/O #3
1943 ORAA #4    RESET FIFO I/O #3
1944 STAA MRFIA
1945 STAA LATCH3
1946 STAA OUFG3  SET OUFG FLAG
1947 INS        *REMOVE RETURN
1948 INS        *
1949 JMP IO4PT
1950 IO3LSX LDAA BPS16K
1951 BEQ IO3LSA
1952 CPX #EBUFF4  16 KBPS
1953 BNE IO3LSB
1954 LDX #SBUFF1
1955 BRA IO3LSB
1956 IO3LSA CPX #EBUFF3  TEST END OF INPUT
1957 BNE IO3LSB  NO
1958 LDX #SBUFF3  GET INITIAL VALUE
1959 IO3LSB STX INPT3
1960 LDX CHCT3  GET CHAR. COUNT
1961 INX          INCR COUNT
1962 STX CHCT3  PUT BACK
1963 RTS
1964 ****
1965 *
1966 *LOAD I/O #3 FIFO WITH 1 CHAR. ROUTINE
1967 *
1968 IO3LF LDX OUTPT3
1969 LDAA RXINHB
1970 BITA #4      IS THE EXTEND TRANSMIT FLAG SET? WBR
1971 BNE IO3LF1  YES:RX NOT ALLOWED WBR
1972 LDAA 0,X
1973 STAA IO3+2  OUTPUT CH. TO I/O #3 FIFO
1974 IO3LF1 INX ADJ. OUTPUT PNTR.
1975 LDAB BPS16K
1976 BEQ IO3LFA
1977 CPX #EBUFF4  16KBPS
1978 BNE IO3LFB
1979 LDX #SBUFF1
1980 BRA IO3LFB
1981 IO3LFA CPX #EBUFF3
1982 BNE IO3LFB
1983 LDX #SBUFF3
1984 IO3LFB STX OUTPT3
1985 LDAA #1
1986 STAA XFER3
1987 LDAA FMSDO3 TEST MISSING DO

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1988      BEQ      IO3LFC
1989      LDX      MDOCT3
1990      DEX
1991      STX      MDOCT3
1992      BNE      IO3LFC
1993      LDAA     SIGACQ
1994      ANDA     #0FBH
1995      STAA     SIGACQ
1996      STAA     LATCH1
1997      CLR      FMSDO3
1998 IO3LFC LDX CHCT3   ADJ CHAR. COUNT
1999      DEX
2000      STX      CHCT3
2001      BNE      IO3LFD
2002      INS      REMOVE RETURN
2003      INS
2004      JMP      IO3YE1   GO CHECK UNDERFLOW
2005 IO3LFD RTS
2006 ****
2007 *
2008 *LOAD FIFO I/O #3 WITH 3 BUF. CH. ROUTINE
2009 *
2010 LD3    LDX      OUTPT3
2011 LDAA   0,X
2012 STAA   IO3+2
2013 LDAA   1,X
2014 STAA   IO3+2
2015 LDAA   2,X
2016 STAA   IO3+2
2017 INX
2018 INX
2019 INX
2020 STX      OUTPT3
2021 LDX      CHCT3
2022 DEX
2023 DEX
2024 DEX
2025 STX      CHCT3
2026 RTS
2027 ****
2028 *
2029 ***** BEGIN SERVICING I/O PORT #3 *****
2030 *
2031 IO3A  LDAA   PTONRX RX ONLY?
2032      BITA   #040H
2033      BEQ    IO3AA
2034      JMP    IO3Y
2035 IO3AA LDAA   DATA1
2036      BITA   #4
2037      BNE    IO3B
2038      JMP    IO3Y
2039 IO3B  ASLA
2040      BPL    IO3C
2041      LDAA   XMTRQ3
2042      BNE    IO3C
2043      LDAA   EMPTY3
2044      BNE    IO3CA

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2045	LDX	CHCT3	R/T SELECTED: CHECK RCV DON
2046	BEQ	IO3BB	
2047	IO3BA	JMP	IO3YD
2048	IO3BB	LDAA	DATA6 TEST: I/O FIFO UNDERFLOW
2049		BITA	#2
2050		BNE	IO3BA BRANCH: NO UNDERFLOW
2051	IO3C	LDAA	XMTREQ3
2052		BNE	IO3D
2053		LDAA	EMPTY3
2054		BEQ	IO3E
2055	IO3CA	CLR	EMPTY3 GET HERE W/MULTIPLE
2056		STAA	XMTREQ3 TX REQ PER FRAME
2057		LDX	#0
2058		STX	LGDPT3
2059		LDAA	MRFTA
2060		ORAA	#040H SET "TX ACK"
2061		STAA	MRFTA
2062		STAA	LATCH3
2063	IO3D	LDAA	OUFG3
2064		BNE	IO3DA
2065		JMP	IO3H
2066	IO3DA	STAA	XFER3
2067		JMP	IO4PT
2068	IO3E	LDAA	DATA5 CHECK TX INHIBIT
2069		ANDA	#1
2070		BEQ	IO3F
2071		JMP	IO4PT
2072	IO3F	LDAA	#1 **INIT FOR PORT #3**
2073		STAA	XMTREQ3 **DATA TRANSMISSION**
2074		STAA	GROUP3
2075		STAA	XFER3
2076		STAA	FLBFG3
2077		LDAA	SIGACQ
2078		ORAA	#040H SET I/O INPUT MODE
2079		ANDA	#0FBH CLR "SIG. ACQ. #3"
2080		STAA	SIGACQ
2081		STAA	LATCH1
2082		LDAA	MRFTA
2083		ORAA	#4 TOGGLE FIFO'S RESET
2084		STAA	LATCH3
2085		CLR	IO3+2 CLR PIA-B SIDE
2086		ANDA	#0FBH
2087		ORAA	#040H SET XMT ACK I/O #3
2088		STAA	MRFTA
2089		STAA	LATCH3
2090		LDAA	BPS16K
2091		BEQ	IO3FA
2092		LDX	#SBUFF1+6 16KBPS
2093		STX	INPT3
2094		LDX	#SBUFF1
2095		BRA	IO3FB
2096	IO3FA	LDX	#SBUFF3+6
2097		STX	INPT3
2098		LDX	#SBUFF3
2099	IO3FB	STX	OUTPT3
2100		LDAA	#0FFH STUFF 6 ELASTIC
2101		STAA	0,X BUFFER CHARACTERS (CC)

2102	STAA	1,X
2103	STAA	2,X
2104	STAA	3,X
2105	STAA	4,X
2106	STAA	5,X
2107	LDX	#6
2108	STX	CHCT3
2109	JMP	IO4PT
2110 IO3G	LDAA	BPS16K
2111	BEQ	IO3GA
2112	LDX	#\$BUFF1 16KBPS
2113	BRA	IO3GB
2114 IO3GA	LDX	#\$BUFF3
2115 IO3GB	STX	INPT3
2116	STX	OUTPT3
2117	LDX	#0
2118	STX	CHCT3
2119	LDAA	SIGACQ CLR "SIGNAL ACQ. I/O #3"
2120	ANDA	#0FBH
2121	STAA	SIGACQ
2122	STAA	LATCH1
2123	JMP	IO4PT
2124 IO3H	LDAA	DATA5 CHECK TX INHIBIT
2125	ANDA	#1
2126	BEQ	IO3HA
2127	JMP	IO3YA1
2128 IO3HA	LDAB	FLBFG3
2129	BEQ	IO3HB
2130	JMP	IO3O
2131 IO3HB	LDAA	DATA6 TEST FIFO "O.R."
2132	BITA	#2
2133	BNE	IO3I
2134	JMP	IO3XP
2135 IO3I	JSR	IO3LS LOAD & STORE 1 CHAR
2136	LDAA	DATA6
2137	BITA	#2
2138	BNE	IO3K
2139	JMP	IO3XP
2140 IO3K	JSR	IO3LS LOAD & STORE 2 CHAR
2141	LDAA	DATA6
2142	BITA	#2
2143	BNE	IO3M
2144	JMP	IO3XP
2145 IO3M	JSR	IO3LS LOAD & STORE 3 CHAR
2146	LDAA	DATA6
2147	BITA	#2
2148	BNE	IO3N2
2149	JMP	IO3XP
2150 IO3N2	JSR	IO3LS LOAD & STORE 4 CHAR
2151	LDAA	BPS16K
2152	BNE	IO3N3
2153	JMP	IO3XP
2154 IO3N3	LDAA	DATA6 *16KBPS: ALLOW MORE*
2155	BITA	#2 *I/O SERVICING*
2156	BNE	IO3N4
2157	JMP	IO3XP
2158 IO3N4	JSR	IO3LS LOAD & STORE 5 CHAR.

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2159      LDAA    DATA6
2160      BITA    #2
2161      BNE     IO3N5
2162      JMP     IO3XP
2163 IO3N5  JSR     IO3LS   LOAD & STORE 6 CHAR.
2164      LDAA    DATA6
2165      BITA    #2
2166      BNE     IO3N6
2167      JMP     IO3XP
2168 IO3N6  JSR     IO3LS   LOD & STORE 7 CHAR.
2169      LDAA    DATA6
2170      BITA    #2
2171      BNE     IO3N7
2172      JMP     IO3XP
2173 IO3N7  JSR     IO3LS   LOAD & STORE 8 CHAR.
2174      LDAA    DATA6
2175      BITA    #2
2176      BNE     IO3N8
2177      JMP     IO3XP
2178 IO3N8  JSR     IO3LS   LOAD & STORE 9 CHAR.
2179      LDAA    DATA6
2180      BITA    #2
2181      BNE     IO3N9
2182      JMP     IO3XP
2183 IO3N9  JSR     IO3LS   LOAD & STORE 10 CHAR.
2184      LDAA   DATA6
2185      BITA    #2
2186      BNE     IO3N10
2187      JMP     IO3XP
2188 IO3N10 JSR     IO3LS   LOAD & STORE 11 CHAR.
2189      JMP     IO3XP
2190 IO3O   LDAA   DATA6
2191      BITA    #2
2192      BEQ    IO3XP
2193 IO3P   CLR    FLBFG3
2194      LDAA   PA1AD   SET "DATA RDY PORT #3"
2195      ORAA   #4
2196      STAA   PA1AD
2197      STAA   PIA1AD
2198      JMP    IO3I
2199 IO3XP  LDAA   EMPTY3  **TEST IF SETUP**
2200      BPL    IO3XQ   **LAST GOOD DATA PNTR**
2201      LDX    INPT3   DO SETUP
2202      STX    LGDPT3
2203      LDAA   #1
2204      STAA   EMPTY3
2205 IO3XQ  JMP    IO4PT
2206 IO3Y   LDAA   XMTRQ3
2207      BEQ    IO3YB
2208      LDAA   MRFIA
2209      ANDA  #0BFH   CLR "TX ACK"
2210      STAA   MRFIA
2211      STAA   LATCH3
2212      CLR    XMTRQ3 FIRST TIME THAT
2213      LDAA   #0FFH   TX REQ = FALSE
2214      STAA   EMPTY3
2215      LDAA   PA1AD

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2216      ANDA    #4
2217      BNE     IO3YA
2218      STAA    CHCT3      NO DATA: ABORT INPUT
2219      STAA    CHCT3+1
2220      STAA    EMPTYY3
2221      INCA
2222      STAA    FLBFG3
2223      LDAA    MRFTA
2224      ORAA    #4
2225      STAA    MRFTA
2226      STAA    LATCH3
2227      JMP     IO4PT
2228 IO3YA  JMP     IO3D
2229 IO3YB  LDAA   EMPTYY3
2230      BNE     IO3YA
2231      JMP     IO3YD
2232 IO3YA1 CLR    PA1AD
2233      STAA    XMTRQ3
2234      STAA    EMPTYY3
2235      LDAA    PA1AD
2236      ANDA    #0FBH
2237      STAA    PIA1AD  CLEAR "DATA RDY PORT #3"
2238      STAA    PA1AD
2239      LDAA    MRFTA
2240      ORAA    #4      RESET I/O #1 FIFO
2241      ANDA    #0BFH  CLR TX ACK I/O #1
2242      STAA    MRFTA
2243      STAA    LATCH3
2244 IO3YC  LDAA    MRFTA  **INIT I/O PORT**
2245      ORAA    #4      **TO OUTPUT**
2246      STAA    MRFTA  **RX BURST DATA**
2247      STAA    LATCH3  RESET I/O #3 FIFO
2248      LDAA    SIGACQ
2249      ANDA    #0BFH  SELECT I/O OUTPUT MODE
2250      STAA    SIGACQ
2251      STAA    LATCH1
2252 IO3YC1 CLR    FMSDO3
2253      LDAA    #2
2254      STAA    MSDO3
2255      STAA    FLBFG3
2256      JMP     IO3G
2257 IO3YD  LDAA    FLBFG3
2258      BEQ    IO3YF
2259      STAA    XFER3
2260      LDAA    CHCT3+1
2261      CMPA    #10    RCV ELASTIC BUFFER FULL?
2262      BGE    IO3YE
2263      JMP     IO4PT
2264 IO3YE  CLR    FLBFG3
2265      STAA    UT3
2266      LDAA    SIGACQ  SET OUTPUT MODE
2267      ANDA    #0BFH
2268      STAA    SIGACQ
2269      STAA    LATCH1
2270      LDAA    MRFTA
2271      ANDA    #0FBH  CLR RESET ON I/O FIFO
2272      STAA    MRFTA

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2273	STAA	LATCH3	
2274	JSR	LD3	
2275	JSR	LD3	LOAD FIFO W/6 BUF. CH.
2276	LDAA	BPS16K	
2277	BEQ	IO3YE0	
2278	JSR	LD3	
2279	JSR	LD3	
2280	JSR	LD3	
2281	JSR	LD3	
2282	JSR	LD3	LOAD FIFO W/21 BUF. CH.
2283	IO3YE0	JMP	IO4PT
2284	IO3YE1	LDAA	#1
2285	STAA	XFER3	
2286	LDAA	UT3	
2287	BNE	IO3YE0	
2288	LDAA	DATA6	CHECK FIFO UNDERFLOW
2289	BITA	#2	BY TESTING FIFO "O.R."
2290	BEQ	IO3YC1	**UNDERFLOW**
2291	JMP	IO4PT	
2292	IO3YF	LDX	CHCT3
2293	BEQ	IO3YE1	
2294	LDAA	DATA6	
2295	LDAB	UT3	
2296	BNE	IO3YFA	
2297	BITA	#2	
2298	BEQ	IO3YC1	
2299	IO3YFA	BITA	#020H CHECK "I.R.": FULL?
2300	BEQ	IO4PT	
2301	IO3YG	JSR	IO3LF OUTPUT 1 CH. TO FIFO
2302	LDAA	DATA6	
2303	BITA	#020H	CHECK "I.R.": FULL?
2304	BEQ	IO4PT	
2305	IO3YH	JSR	IO3LF OUTPUT 2 CH. TO FIFO
2306	LDAA	DATA6	
2307	BITA	#020H	CHECK "I.R.": FULL?
2308	BEQ	IO4PT	
2309	IO3YI	JSR	IO3LF OUTPUT 3 CH. TO FIFO
2310	LDAA	BPS16K	
2311	BEQ	IO4PT	
2312	IO3YJ	LDAA	DATA6 16 KBPS: SERVICE 10 CHARS.
2313	BITA	#020H	CHECK "I.R.": FULL?
2314	BEQ	IO4PT	
2315	IO3YK	JSR	IO3LF OUTPUT 4 CH. TO FIFO
2316	LDAA	DATA6	
2317	BITA	#020H	CHECK "I.R.": FULL?
2318	BEQ	IO4PT	
2319	IO3YL	JSR	IO3LF OUTPUT 5 CH. TO FIFO
2320	LDAA	DATA6	
2321	BITA	#020H	CHECK "I.R.": FULL?
2322	BEQ	IO4PT	
2323	IO3YM	JSR	IO3LF OUTPUT 6 CH. TO FIFO
2324	LDAA	DATA6	
2325	BITA	#020H	CHECK "I.R.": FULL?
2326	BEQ	IO4PT	
2327	IO3YN	JSR	IO3LF OUTPUT 7 CH. TO FIFO
2328	LDAA	DATA6	
2329	BITA	#020H	CHECK "I.R.": FULL?

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2330      BEQ    IO4PT
2331 IO3YO  JSR    IO3LF   OUTPUT 8 CH. TO FIFO
2332      LDAA   DATA6
2333      BITA   #020H   CHECK "I.R.": FULL?
2334      BEQ    IO4PT
2335 IO3YP  JSR    IO3LF   OUTPUT 9 CH. TO FIFO
2336      LDAA   DATA6
2337      BITA   #020H   CHECK "I.R.": FULL?
2338      BEQ    IO4PT
2339 IO3YQ  JSR    IO3LF   OUTPUT 10 CH. TO FIFO
2340 ****
2341 *
2342 *
2343 *
2344 IO4PT  LDAA   PTONRX  PORT #4 ON?
2345      ANDA   #8
2346      BEQ    IO4A1
2347      CLR    P4OFF
2348      JMP    IO4A
2349 IO4A1  LDAA   P4OFF   PORT IS OFF
2350      BEQ    IO4A2
2351      JMP    BSERV
2352 IO4A2  STAA   CHCT4
2353      STAA   CHCT4+1
2354      STAA   XMTRQ4
2355      STAA   UT4
2356      LDX    #0
2357      STX    LGDPT4
2358      STAA   OUFG4
2359      STAA   EMPTY4
2360      LDAA   #2
2361      STAA   MSDO4
2362      INCA
2363      STAA   FLBFG4
2364      LDAA   MRFTA
2365      ORAA   #8      RESET FIFO I/O #4
2366      ANDA   #07FH   CLR XMT ACK
2367      STAA   MRFTA
2368      STAA   LATCH3
2369      STAA   P4OFF
2370      LDAA   PA1AD
2371      ANDA   #0F7H   CLEAR "DATA RDY PORT #4"
2372      STAA   PA1AD
2373      STAA   PIA1AD
2374      LDX    #SBUFF4
2375      STX    INPT4
2376      STX    OUTPT4
2377      LDAA   SIGACQ  CLR "SIGNAL ACQ. I/O #4"
2378      ANDA   #0F7H
2379      STAA   SIGACQ
2380      STAA   LATCH1
2381      LDX    TXPNTR
2382      CPX    #INPT4
2383      BNE    IO4A3
2384      CLR    SOEN
2385 IO4A3  JMP    BSERV
2386 ****

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2387 *
2388 *      INPUT SERVICE SUBROUTINE
2389 *
2390 IO4LS  LDAA  #1
2391      STAA  XFER4
2392      LDAA  IO4      OBTAIN CHAR
2393      LDX   INPT4  GET PUT PNTR
2394      STAA  0,X      PUT IT
2395      INX   IO4      INCR PUT PNTR
2396      CPX   OUTPT4 TEST OVERFLOW
2397      BNE   IO4LSX BRANCH NO OVERFLOW
2398      LDAA  MRFTA  **OVERFLOW**
2399      ANDA #07FH CLR XMT ACK
2400      ORAA #8      RESET FIFO
2401      STAA  MRFTA
2402      STAA  LATCH3
2403      STAA  OUFG4 SET OUFG FLAG
2404      INS   *REMOVE RETURN
2405      INS   *
2406      JMP   BSERV
2407 IO4LSX LDAA BPS16K
2408      BEQ   IO4LSA
2409      CPX   #EBUFF4 16 KBPS
2410      BNE   IO4LSB
2411      LDX   #SBUFF1
2412      BRA   IO4LSB
2413 IO4LSA CPX   #EBUFF4 TEST END OF INPUT
2414      BNE   IO4LSB NO
2415      LDX   #SBUFF4 GET INITIAL VALUE
2416 IO4LSB STX   INPT4
2417      LDX   CHCT4 GET CHAR COUNT
2418      INX   IO4LSB INC COUNT
2419      STX   CHCT4 PUT BACK
2420      RTS
2421 ****
2422 *
2423 *LOAD I/O #4 FIFO WITH 1 CHAR. ROUTINE
2424 *
2425 IO4LF  LDX   OUTPT4
2426      LDAA  RXINHB
2427      BITA #8      IS THE EXTEND TRANSMIT FLAG SET? WBR
2428      BNE   IO4LF1 YES:RX NOT ALLOWED WBR
2429      LDAA  0,X
2430      STAA  IO4+2 OUTPUT CH. TO I/O #4 FIFO
2431 IO4LF1 INX   ADJ. OUTPUT PNTR.
2432      LDAB  BPS16K
2433      BEQ   IO4LFA
2434      CPX   #EBUFF4 16KBPS
2435      BNE   IO4LFB
2436      LDX   #SBUFF1
2437      BRA   IO4LFB
2438 IO4LFA CPX   #EBUFF4
2439      BNE   IO4LFB
2440      LDX   #SBUFF4
2441 IO4LFB STX   OUTPT4
2442      LDAA  #1
2443      STAA  XFER4

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2444      LDAA    FMSDO4   TEST MISSING DO
2445      BEQ     IO4LFC
2446      LDX     MDOCT4
2447      DEX
2448      STX     MDOCT4
2449      BNE     IO4LFC
2450      LDAA    SIGACQ
2451      ANDA    #0F7H
2452      STAA    SIGACQ
2453      STAA    LATCH1
2454      CLR     FMSDO4
2455 IO4LFC LDX     CHCT4    ADJUST CHR COUNT
2456      DEX
2457      STX     CHCT4
2458      BNE     IO4LFD
2459      INS     REMOVE RETURN
2460      INS
2461      JMP     IO4YE1   GO CHECK UNDERFLOW
2462 IO4LFD RTS
2463 ****
2464 *
2465 *LOAD FIFO I/O #4 WITH 3 BUF. CH. ROUTINE
2466 *
2467 LD4     LDX     OUTPT4
2468      LDAA    0,X
2469      STAA    IO4+2
2470      LDAA    1,X
2471      STAA    IO4+2
2472      LDAA    2,X
2473      STAA    IO4+2
2474      INX
2475      INX
2476      INX
2477      STX     OUTPT4
2478      LDX     CHCT4
2479      DEX
2480      DEX
2481      DEX
2482      STX     CHCT4
2483      RTS
2484 ****
2485 *
2486 ***** BEGIN SERVICING I/O PORT #4 *****
```

2487 *

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2488 IO4A    LDAA    PTONRX  RX ONLY?
2489      BITA    #080H
2490      BEQ     IO4AA
2491      JMP     IO4Y
2492 IO4AA  LDAA    DATA1
2493      BITA    #8
2494      BNE     IO4B
2495      JMP     IO4Y
2496 IO4B    ASLA
2497      BPL     IO4C
2498      LDAA    XMTRQ4
2499      BNE     IO4C
2500      LDAA    EMPTY4

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2501	BNE	IO4CA	
2502	LDX	CHCT4	R/T SELECTED: CHECK RCV DON
2503	BEQ	IO4BB	
2504	IO4BA	JMP	IO4YD
2505	IO4BB	LDAAA	DATA6 TEST: I/O FIFO UNDERFLOW
2506		BITA	#1
2507		BNE	IO4BA BRANCH: NO UNDERFLOW
2508	IO4C	LDAAA	XMTRO4
2509		BNE	IO4D
2510		LDAAA	EMPTY4
2511		BEQ	IO4E
2512	IO4CA	CLR	EMPTY4 GET HERE W/MULTIPLE
2513		STAA	XMTRO4 TX REQ PER FRAME
2514		LDX	#0
2515		STX	LGDPT4
2516		LDAAA	MRFTA
2517		ORAA	#080H SET "TX ACK"
2518		STAA	MRFTA
2519		STAA	LATCH3
2520	IO4D	LDAAA	OUFG4
2521		BNE	IO4DA
2522		JMP	IO4H
2523	IO4DA	STAA	XFER4
2524		JMP	BSERV
2525	IO4E	LDAAA	DATA5 CHECK TX INHIBIT
2526		ANDA	#1
2527		BEQ	IO4F
2528		JMP	BSERV
2529	IO4F	LDAAA	#1 **INIT FOR PORT #4**
2530		STAA	XMTRO4 **DATA TRANSMISSION**
2531		STAA	GROUP4
2532		STAA	XFER4
2533		STAA	FLBFG4
2534		LDAAA	SIGACQ
2535		ORAA	#080H SELECT I/O INPUT MODE
2536		ANDA	#0F7H CLR "SIG. ACQ. #4"
2537		STAA	SIGACQ
2538		STAA	LATCH1
2539		LDAAA	MRFTA
2540		ORAA	#8 TOGGLE FIFO'S RESET
2541		STAA	LATCH3
2542		CLR	IO4+2 CLR PIA-B SIDE
2543		ANDA	#0F7H
2544		ORAA	#080H SET XMT ACK I/O #4
2545		STAA	MRFTA
2546		STAA	LATCH3
2547		LDAAA	BPS16K
2548		BEQ	IO4FA
2549		LDX	#SBUFF1+6 16KBPS
2550		STX	INPT4
2551		LDX	#SBUFF1
2552		BRA	IO4FB
2553	IO4FA	LDX	#SBUFF4+6
2554		STX	INPT4
2555		LDX	#SBUFF4
2556	IO4FB	STX	OUTPT4
2557		LDAAA	#0FFH STUFF 6 ELASTIC

2558	STAA	0,X	BUFFER CHARACTERS (CC)
2559	STAA	1,X	
2560	STAA	2,X	
2561	STAA	3,X	
2562	STAA	4,X	
2563	STAA	5,X	
2564	LDX	#6	
2565	STX	CHCT4	
2566	JMP	BSERV	
2567 IO4G	LDAA	BPS16K	
2568	BEQ	IO4GA	
2569	LDX	#SBUFF1 16 KBPS	
2570	BRA	IO4GB	
2571 IO4GA	LDX	#SBUFF4	
2572 IO4GB	STX	INPT4	
2573	STX	OUTPT4	
2574	LDX	#0	
2575	STX	CHCT4	
2576	LDAA	SIGACQ CLR "SIGNAL ACQ. I/O #4"	
2577	ANDA	#0F7H	
2578	STAA	SIGACQ	
2579	STAA	LATCH1	
2580	JMP	BSERV	
2581 IO4H	LDAA	DATA5 CHECK TX INHIBIT	
2582	ANDA	#1	
2583	BEQ	IO4HA	
2584	JMP	IO4YA1	
2585 IO4HA	LDAB	FLBFG4	
2586	BEQ	IO4HB	
2587	JMP	IO4O	
2588 IO4HB	LDAA	DATA6 TEST FIFO "O.R."	
2589	BITA	#1	
2590	BNE	IO4I	
2591	JMP	IO4XP	
2592 IO4I	JSR	IO4LS LOAD & STORE 1 CHAR	
2593	LDAA	DATA6	
2594	BITA	#1	
2595	BNE	IO4K	
2596	JMP	IO4XP	
2597 IO4K	JSR	IO4LS LOAD & STORE 2 CHAR	
2598	LDAA	DATA6	
2599	BITA	#1	
2600	BNE	IO4M	
2601	JMP	IO4XP	
2602 IO4M	JSR	IO4LS LOAD \$ STORE 3 CHAR.	
2603	LDAA	DATA6	
2604	BITA	#1	
2605	BNE	IO4N2	
2606	JMP	IO4XP	
2607 IO4N2	JSR	IO4LS LOAD & STORE 4 CHAR	
2608	LDAA	BPS16K	
2609	BNE	IO4N3	
2610	JMP	IO4XP	
2611 IO4N3	LDAA	DATA6 *16 KBPS: ALLOW MORE*	
2612	BITA	#1 *I/O SERVICING*	
2613	BNE	IO4N4	
2614	JMP	IO4XP	

2615	IO4N4	JSR	IO4LS	LOAD & STORE 5 CHAR.
2616		LDAAA	DATA6	
2617		BITA	#1	
2618		BNE	IO4N5	
2619		JMP	IO4XP	
2620	IO4N5	JSR	IO4LS	LOAD & STORE 6 CHAR.
2621		LDAAA	DATA6	
2622		BITA	#1	
2623		BNE	IO4N6	
2624		JMP	IO4XP	
2625	IO4N6	JSR	IO4LS	LOAD & STORE 7 CHAR.
2626		LDAAA	DATA6	
2627		BITA	#1	
2628		BNE	IO4N7	
2629		JMP	IO4XP	
2630	IO4N7	JSR	IO4LS	LOAD & STORE 8 CHAR.
2631		LDAAA	DATA6	
2632		BITA	#1	
2633		BNE	IO4N8	
2634		JMP	IO4XP	
2635	IO4N8	JSR	IO4LS	LOAD & STORE 9 CHAR.
2636		LDAAA	DATA6	
2637		BITA	#1	
2638		BNE	IO4N9	
2639		JMP	IO4XP	
2640	IO4N9	JSR	IO4LS	LOAD & STORE 10 CHAR.
2641		LDAAA	DATA6	
2642		BITA	#1	
2643		BNE	IO4N10	
2644		JMP	IO4XP	
2645	IO4N10	JSR	IO4LS	LOAD & STORE 11 CHAR.
2646		JMP	IO4XP	
2647	IO4O	LDAAA	DATA6	
2648		BITA	#1	
2649		BEQ	IO4XP	
2650	IO4P	CLR	FLBFG4	
2651		LDAAA	PA1AD	SET "DATA RDY PORT #4"
2652		ORAA	#8	
2653		STAA	PA1AD	
2654		STAA	PIA1AD	
2655		JMP	IO4I	
2656	IO4XP	LDAAA	EMPTY4	**TEST IF SETUP**
2657		BPL	IO4XQ	**LAST GOOD DATA PNTR**
2658		LDX	INPT4	DO SETUP
2659		STX	LGDPT4	
2660		LDAAA	#1	
2661		STAA	EMPTY4	
2662	IO4XQ	JMP	BSERV	
2663	IO4Y	LDAAA	XMTRQ4	
2664		BEQ	IO4YB	
2665		LDAAA	MRFTA	
2666		ANDA	#07FH	CLR "TX ACK"
2667		STAA	MRFTA	
2668		STAA	LATCH3	
2669		CLR	XMTRQ4	FIRST TIME THAT
2670		LDAAA	#0FFH	TX REQ = FALSE
2671		STAA	EMPTY4	

2672	LDAA	PA1AD	
2673	ANDA	#8	
2674	BNE	IO4YA	
2675	STAA	CHCT4	NO DATA: ABORT INPUT
2676	STAA	CHCT4+1	
2677	STAA	EMPTY4	
2678	INCA		
2679	STAA	FLBFG4	
2680	LDAA	MRFTA	
2681	ORAA	#8	
2682	STAA	MRFTA	
2683	STAA	LATCH3	
2684	JMP	BSERV	
2685	IO4YA	JMP	IO4D
2686	IO4YB	LDAA	EMPTY4
2687	BNE	IO4YA	
2688	JMP	IO4YD	
2689	IO4YA1	CLRA	
2690	STAA	XMTRO4	
2691	STAA	EMPTY4	
2692	LDAA	PA1AD	
2693	ANDA	#0F7H	
2694	STAA	PIA1AD	CLEAR "DATA RDY PORT #4"
2695	STAA	PA1AD	
2696	LDAA	MRFTA	
2697	ORAA	#8	RESET I/O #4 FIFO
2698	ANDA	#07FH	CLR TX ACK I/O #4
2699	STAA	MRFTA	
2700	STAA	LATCH3	
2701	IO4YC	LDAA	MRFTA **INIT I/O PORT**
2702	ORAA	#8	**TO OUTPUT**
2703	STAA	MRFTA	**RX BURST DATA**
2704	STAA	LATCH3	RESET I/O #4 FIFO
2705	LDAA	SIGACQ	
2706	ANDA	#07FH	SELECT I/O OUTPUT MODE
2707	STAA	SIGACQ	
2708	STAA	LATCH1	
2709	IO4YC1	CLR	FMSDO4
2710	LDAA	#2	
2711	STAA	MSDO4	
2712	STAA	FLBFG4	
2713	JMP	IO4G	
2714	IO4YD	LDAA	FLBFG4
2715	BEQ	IO4YF	
2716	STAA	XFER4	
2717	LDAA	CHCT4+1	
2718	CMPA	#10	RCV ELASTIC BUFFER FULL?
2719	BGE	IO4YE	
2720	JMP	BSERV	
2721	IO4YE	CLR	FLBFG4
2722	STAA	UT4	
2723	LDAA	SIGACQ	SET OUTPUT MODE
2724	ANDA	#07FH	
2725	STAA	SIGACQ	
2726	STAA	LATCH1	
2727	LDAA	MRFTA	
2728	ANDA	#0F7H	RESET ON I/O FIFO

2729	STAA	MRFTA	
2730	STAA	LATCH3	
2731	JSR	LD4	
2732	JSR	LD4	LOAD FIFO W/6 BUF. CH.
2733	LDAA	BPS16K	
2734	BEQ	IO4YE0	
2735	JSR	LD4	16 KBPS SO:
2736	JSR	LD4	
2737	JSR	LD4	
2738	JSR	LD4	
2739	JSR	LD4	LOAD FIFO W/21 BUF. CH.
2740	IO4YE0	JMP	BSERV
2741	IO4YE1	LDAA	#1
2742	STAA	XFER4	
2743	LDAA	UT4	
2744	BNE	IO4YE0	
2745	LDAA	DATA6	CHECK FIFO UNDERFLOW
2746	BITA	#1	BY TESTING FIFO "O.R."
2747	BEQ	IO4YC1	**UNDERFLOW**
2748	JMP	BSERV	
2749	IO4YF	LDX	CHCT4
2750		BEQ	IO4YE1
2751		LDAA	DATA6
2752		LDAB	UT4
2753		BNE	IO4YFA
2754		BITA	#1
2755		BEQ	IO4YC1
2756	IO4YFA	BITA	#010H CHECK "I.R.": FULL?
2757		BEQ	BSERV
2758	IO4YG	JSR	IO4LF OUTPUT 1 CHAN. TO FIFO
2759		LDAA	DATA6
2760		BITA	#010H CHECK "I.R.": FULL?
2761		BEQ	BSERV
2762	IO4YH	JSR	IO4LF OUTPUT 2 CH. TO FIFO
2763		LDAA	DATA6
2764		BITA	#010H CHECK "I.R.": FULL?
2765		BEQ	BSERV
2766	IO4YI	JSR	IO4LF OUTPUT 3 CH. TO FIFO
2767		LDAA	BPS16K
2768		BEQ	BSERV
2769	IO4YJ	LDAA	DATA6 16KBPS: SERVICE 10 CHAR.
2770		BITA	#010H CHECK "I.R.": FULL?
2771		BEQ	BSERV
2772	IO4YK	JSR	IO4LF OUTPUT 4 CH. TO FIFO
2773		LDAA	DATA6
2774		BITA	#010H CHECK "I.R.": FULL?
2775		BEQ	BSERV
2776	IO4YL	JSR	IO4LF OUTPUT 5 CH. TO FIFO
2777		LDAA	DATA6
2778		BITA	#010H CHECK "I.R.": FULL?
2779		BEQ	BSERV
2780	IO4YM	JSR	IO4LF OUTPUT 6 CH. TO FIFO
2781		LDAA	DATA6
2782		BITA	#010H CHECK "I.R.": FULL?
2783		BEQ	BSERV
2784	IO4YN	JSR	IO4LF OUTPUT 7 CH. TO FIFO
2785		LDAA	DATA6

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2786      BITA    #010H    CHECK "I.R.": FULL?
2787      BEQ     BSERV
2788 IO4YO   JSR     IO4LF    OUTPUT 8 CH. TO FIFO
2789      LDAA   DATA6
2790      BITA    #010H    CHECK "I.R.": FULL?
2791      BEQ     BSERV
2792 IO4YP   JSR     IO4LF    OUTPUT 9 CH. TO FIFO
2793      LDAA   DATA6
2794      BITA    #010H    CHECK "I.R.": FULL?
2795 IO4YQ   JSR     IO4LF    OUTPUT 10 CH. TO FIFO
2796 ****
2797 *
2798 *     BITE SERVICE ROUTINE
2799 *
2800 *
2801 BSERV   LDAA   DATA5
2802      BITA    #8      TEST: SYSTEM BITE RESET
2803      BEQ     BSERVA
2804      CLR     IRSBIT
2805      CLR     BITLET
2806 BSERVA  BITA    #04H    TEST: LAMP TEST
2807      BEQ     BSERVB
2808      LDAA   #0FFH   TURN ALL BITE LITES ON
2809      BRA    BSERVC
2810 *
2811 *
2812 *
2813 *
2814 *
2815 *
2816 *
2817 *
2818 *
2819 *
2820 *
2821 BSERVB  LDAA   RXINHB
2822      ASLA
2823      COMA
2824      ANDA   BITLET
2825      STAA   BITLET
2826 BSERVC   STAA   LATCH2
2827      LDAB   DATA5
2828      LDAA   TIMEFG
2829      BEQ    BSERVF
2830      BITB   #010H   TEST 75/16 HZ CLOCK
2831      BNE    BSERVE
2832 BSERVD   CLR    TIMEFG
2833 BSERVE   JMP    SOF
2834 BSERVF   BITB   #010H   TEST 75/16 HZ CLOCK
2835      BEQ    BSERVE
2836      INC    TIMEFG
2837      LDAB   BITLET
2838      LDX    CHCT1
2839      BEQ    SERVF3
2840 SERVF1   LDAA   XFER1
2841      BEQ    SERVF2
2842      CLR    XFER1

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2843      BRA    BSERVG
2844 SERVF2 ORAB #2      I/O #1 BITE ERROR
2845      BRA    BSERVG
2846 SERVF3 LDAA XMTRQ1 NO DATA AFTER TX REQ?
2847      BNE    SERVF1
2848 BSERVG LDX  CHCT2
2849      BEQ    SERVG3
2850 SERVG1 LDAA XFER2
2851      BEQ    SERVG2
2852      CLR    XFER2
2853      BRA    BSERVH
2854 SERVG2 ORAB #4      I/O #2 BITE ERROR
2855      BRA    BSERVH
2856 SERVG3 LDAA XMTRQ2 NO DATA AFTER TX REQ?
2857      BNE    SERVG1
2858 BSERVH LDX  CHCT3
2859      BEQ    SERVH3
2860 SERVH1 LDAA XFER3
2861      BEQ    SERVH2
2862      CLR    XFER3
2863      BRA    BSERVI
2864 SERVH2 ORAB #8      I/O #3 BITE ERROR
2865      BRA    BSERVI
2866 SERVH3 LDAA XMTRQ3 NO DATA AFTER TX REQ?
2867      BNE    SERVH1
2868 BSERVI LDX  CHCT4
2869      BEQ    SERVI3
2870 SERVI1 LDAA XFER4
2871      BEQ    SERVI2
2872      CLR    XFER4
2873      BRA    BSERVK
2874 SERVI2 ORAB #010H   I/O #4 BITE ERROR
2875      BRA    BSERVK
2876 SERVI3 LDAA XMTRQ4 NO DATA AFTER TX REQ?
2877      BNE    SERVI1
2878 BSERVK STAB  BITELT
2879 ****
2880 *
2881 *      BEGIN SERVICING SYSTEM OUTPUT FIFO
2882 *
2883 SOF   LDAA  SOEN
2884      BEQ    SOF1
2885      BSR    SOFA
2886 SOF1  JMP   SIF
2887 *
2888 SOF2  LDX   OUTCHC *TX SELF TEST ROUTINE*
2889      LDAB   #16
2890 SOF3  LDAA  DATA5  FIFO RDY?
2891      BMI    SOF5
2892      LDAA  #033H  OUTPUT TEST CHAR.
2893      STA   PIA1BD
2894      DEX
2895      BNE    SOF4
2896      CLRA   DONE SELF TEST TX
2897      STA   SOEN
2898      STA   SELFTT
2899      STX   OUTCHC

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2900		RTS		
2901	SOF4	DEC B		
2902		BNE	SOF3	
2903	SOF5	STX	OUTCHC	
2904		RTS		
2905	*			
2906	SOFA	LDA A	SELF TT	TX SELF TEST?
2907		BNE	SOF2	
2908		LDX	TXPNTR	
2909		LDA A	DATA5	CHECK TX INHIBIT
2910		BIT A	#1	
2911		BEQ	SOF AA	
2912		CLR	SOEN	TX INHIBIT: ABORT
2913		RTS		
2914	SOFAA	LDX	2,X	
2915		STX	TBPNTR	
2916		LDX	TXPNTR	
2917		LDX	4,X	
2918		STX	TXCHCT	
2919		LDX	TXPNTR	
2920		LDX	14,X	SETUP L.G.D. PNTR FOR
2921		STX	TXLGDP	TX BURST SERVICE
2922		LDA A	GRP1FG	
2923		BNE	SOF B	
2924		JMP	SOF Y	
2925	SOF B	LDX	FILLCT	
2926		LDAB	#0FFH	FILL PATTERN BEFORE DATA
2927		LDA A	DATA5	FIFO RDY? (DATA5-H=LOW)
2928		BPL	SOF BA	
2929		STX	FILLCT	
2930		RTS		
2931	SOF BA	STAB	PIA1BD	OUTPUT FILL CHAR #1
2932		DEX		
2933		BNE	SOF BB	
2934		CLR	GRP1FG	
2935		JMP	SOF D+2	
2936	SOF BB	LDA A	DATA5	FIFO READY?
2937		BPL	SOF BC	
2938		STX	FILLCT	
2939		RTS		
2940	SOF BC	STAB	PIA1BD	OUTPUT FILL CHAR #2
2941		DEX		
2942		BNE	SOF BD	
2943		CLR	GRP1FG	
2944		JMP	SOF E+2	
2945	SOF BD	LDA A	DATA5	FIFO READY?
2946		BPL	SOF BE	
2947		STX	FILLCT	
2948		RTS		
2949	SOF BE	STAB	PIA1BD	OUTPUT FILL CHAR #3
2950		DEX		
2951		BNE	SOF BF	
2952		CLR	GRP1FG	
2953		JMP	SOF F+2	
2954	SOF BF	LDA A	DATA5	FIFO READY?
2955		BPL	SOF BG	
2956		STX	FILLCT	

2957		RTS	
2958	SOFBG	STAB	PIA1BD OUTPUT FILL CHAR #4
2959		DEX	
2960		BNE	SOFBH
2961		CLR	GRP1FG
2962		JMP	SOFG+2
2963	SOFBH	LDAA	DATA5 FIFO READY?
2964		BPL	SOFBI
2965		STX	FILLCT
2966		RTS	
2967	SOFBI	STAB	PIA1BD OUTPUT FILL CHAR #5
2968		DEX	
2969		BNE	SOFBJ
2970		CLR	GRP1FG
2971		JMP	SOFH+2
2972	SOFBJ	LDAA	DATA5 FIFO READY?
2973		BPL	SOFBK
2974		STX	FILLCT
2975		RTS	
2976	SOFBK	STAB	PIA1BD OUTPUT FILL CHAR #6
2977		DEX	
2978		BNE	SOFBL
2979		CLR	GRP1FG
2980		JMP	SOFI+2
2981	SOFBL	LDAA	DATA5 FIFO READY?
2982		BPL	SOFBM
2983		STX	FILLCT
2984		RTS	
2985	SOFBM	STAB	PIA1BD OUTPUT FILL CHAR #7
2986		DEX	
2987		BNE	SOFBN
2988		CLR	GRP1FG
2989		JMP	SOFJ+2
2990	SOFBN	LDAA	DATA5 FIFO READY?
2991		BPL	SOFBO
2992		STX	FILLCT
2993		RTS	
2994	SOFBO	STAB	PIA1BD OUTPUT FILL CHAR #8
2995		DEX	
2996		BNE	SOFBP
2997		CLR	GRP1FG
2998		JMP	SOKF+2
2999	SOFBP	LDAA	DATA5 FIFO READY?
3000		BPL	SOFBQ
3001		STX	FILLCT
3002		RTS	
3003	SOFBQ	STAB	PIA1BD OUTPUT FILL CHAR #9
3004		DEX	
3005		BNE	SOFBR
3006		CLR	GRP1FG
3007		JMP	SOFL+2
3008	SOFBR	LDAA	DATA5 FIFO READY?
3009		BPL	SOFBS
3010		STX	FILLCT
3011		RTS	
3012	SOFBS	STAB	PIA1BD OUTPUT FILL CHAR #10
3013		DEX	

3014		BNE	SOFBT	
3015		CLR	GRP1FG	
3016		JMP	SOFM+2	
3017	SOFBT	LDAA	DATA5	FIFO READY?
3018		BPL	SOFBU	
3019		STX	FILLCT	
3020		RTS		
3021	SOFBU	STAB	PIA1BD	OUTPUT FILL CHAR #11
3022		DEX		
3023		BNE	SOFBV	
3024		CLR	GRP1FG	
3025		JMP	SOFN+2	
3026	SOFBV	LDAA	DATA5	FIFO READY?
3027		BPL	SOFBW	
3028		STX	FILLCT	
3029		RTS		
3030	SOFBW	STAB	PIA1BD	OUTPUT FILL CHAR #12
3031		DEX		
3032		BNE	SOFBX	
3033		CLR	GRP1FG	
3034		JMP	SOFO+2	
3035	SOFBX	LDAA	DATA5	FIFO READY?
3036		BPL	SOFBY	
3037		STX	FILLCT	
3038		RTS		
3039	SOFBY	STAB	PIA1BD	OUTPUT FILL CHAR #13
3040		DEX		
3041		BNE	SOFBZ	
3042		CLR	GRP1FG	
3043		JMP	SOFP+2	
3044	SOFBZ	LDAA	DATA5	FIFO READY?
3045		BPL	SOFB1	
3046		STX	FILLCT	
3047		RTS		
3048	SOFB1	STAB	PIA1BD	OUTPUT FILL CHAR #14
3049		DEX		
3050		BNE	SOFB2	
3051		CLR	GRP1FG	
3052		JMP	SOFQ+2	
3053	SOFB2	LDAA	DATA5	FIFO READY?
3054		BPL	SOFB3	
3055		STX	FILLCT	
3056		RTS		
3057	SOFB3	STAB	PIA1BD	OUTPUT FILL CHAR #15
3058		DEX		
3059		BNE	SOFB4	
3060		CLR	GRP1FG	
3061		JMP	SOFR+2	
3062	SOFB4	LDAA	DATA5	FIFO READY?
3063		BPL	SOFB5	
3064		STX	FILLCT	
3065		RTS		
3066	SOFB5	STAB	PIA1BD	OUTPUT FILL CHAR #16
3067		DEX		
3068		BNE	SOFB6	
3069		CLR	GRP1FG	
3070	SOFB6	STX	FILLCT	

3071		RTS	
3072	SOF C	LDA A	DATA5 FIFO READY?
3073		BPL	SOFCA
3074		JMP	SOFS
3075	SOFCA	LDX	TXCHCT
3076		BNE	SOFCB
3077		LDA A	#0FFH GET STUFF CHAR
3078		STA A	TXEND
3079		LDX	TXPNTR
3080		STA A	13,X SET PORT'S OUFG
3081		BRA	SOFCD
3082	SOFCB	DEX	
3083		STX	TXCHCT
3084		LDX	TBPNTR
3085		LDA A	0,X GET BUFF CHAR
3086		INX	
3087		CPX	TXUVAL ADJ BUFF PNTRS
3088		BNE	SOFCC
3089		LDX	TXLVAL
3090	SOFCC	STX	TBPNTR
3091		CPX	TXLGDP LAST GOOD DATA?
3092		BNE	SOFCD
3093		LDX	#0 YES
3094		STX	TXLGDP
3095		STAB	TXDONE
3096	SOFCD	STA A	PIA1BD OUTPUT CHAR #1
3097		LDX	OUTCHC
3098		DEX	
3099		BNE	SOFD
3100		JMP	SOFT
3101	SOFD	STX	OUTCHC
3102		LDA A	DATA5 FIFO READY?
3103		BPL	SOFDA
3104		JMP	SOFS
3105	SOFDA	LDX	TXCHCT
3106		BNE	SOFDB
3107		LDA A	#0FFH GET STUFF CHAR
3108		STA A	TXEND
3109		LDX	TXPNTR
3110		STA A	13,X
3111		BRA	SOFDD
3112	SOFDB	DEX	
3113		STX	TXCHCT
3114		LDX	TBPNTR
3115		LDA A	0,X GET BUFF CHAR
3116		INX	
3117		CPX	TXUVAL ADJ BUFF PNTRS
3118		BNE	SOFDC
3119		LDX	TXLVAL
3120	SOFDC	STX	TBPNTR
3121		CPX	TXLGDP LAST GOOD DATA?
3122		BNE	SOFDD
3123		LDX	#0 YES
3124		STX	TXLGDP
3125		STAB	TXDONE
3126	SOFDD	STA A	PIA1BD OUTPUT CHAR #2
3127		LDX	OUTCHC

3128	DEX	
3129	BNE	SOF E
3130	JMP	SOFT
3131 SOFE	STX	OUTCHC
3132	LDA A	DATA5 FIFO READY?
3133	BPL	SOF EA
3134	JMP	SOFS
3135 SOFEA	LDX	TXCHCT
3136	BNE	SOF EB
3137	LDA A	#0FFH GET STUFF CHAR
3138	STA A	TXEND
3139	LDX	TXPNTR
3140	STA A	13,X SET PORT'S UOFG
3141	BRA	SOF ED
3142 SOFEB	DEX	
3143	STX	TXCHCT
3144	LDX	TBPNTR
3145	LDA A	0,X GET BUFF CHAR
3146	INX	
3147	CPX	TXUVAL ADJ BUFF PNTRS
3148	BNE	SOF EC
3149	LDX	TXLVAL
3150 SOFEC	STX	TBPNTR
3151	CPX	TXLGDP LAST GOOD DATA?
3152	BNE	SOF ED
3153	LDX	#0 YES
3154	STX	TXLGDP
3155	STAB	TXDONE
3156 SOFED	STA A	PIA1BD OUTPUT CHAR #3
3157	LDX	OUTCHC
3158	DEX	
3159	BNE	SOFF
3160	JMP	SOFT
3161 SOFF	STX	OUTCHC
3162	LDA A	DATA5 FIFO READY?
3163	BPL	SOFFA
3164	JMP	SOFS
3165 SOFFA	LDX	TXCHCT
3166	BNE	SOFFB
3167	LDA A	#0FFH GET STUFF CHAR
3168	STA A	TXEND
3169	LDX	TXPNTR
3170	STA A	13,X SET PORT'S OUFG
3171	BRA	SOFFD
3172 SOFFB	DEX	
3173	STX	TXCHCT
3174	LDX	TBPNTR
3175	LDA A	0,X GET BUFF CHAR
3176	INX	
3177	CPX	TXUVAL ADJ BUFF PNTRS
3178	BNE	SOFFC
3179	LDX	TXLVAL
3180 SOFFC	STX	TBPNTR
3181	CPX	TXLGDP LAST GOOD DATA?
3182	BNE	SOFFD
3183	LDX	#0 YES
3184	STX	TXLGDP

3185	STAB	TXDONE	
3186 SOFFD	STAA	PIA1BD	OUTPUT CHAR #4
3187	LDX	OUTCHC	
3188	DEX		
3189	BNE	SOFG	
3190	JMP	SOFT	
3191 SOFG	STX	OUTCHC	
3192	LDAA	DATA5	FIFO READY?
3193	BPL	SOFGA	
3194	JMP	SOF S	
3195 SOFGA	LDX	TXCHCT	
3196	BNE	SOFGB	
3197	LDAA	#0FFH	GET STUFF CHAR
3198	STAA	TXEND	
3199	LDX	TXPNTR	
3200	STAA	13,X	SET PORT'S OUF G
3201	BRA	SOFGD	
3202 SOFGB	DEX		
3203	STX	TXCHCT	
3204	LDX	TBPNTR	
3205	LDAA	0,X	GET BUFF CHAR
3206	INX		
3207	CPX	TXUVAL	ADJ BUFF PNTRS
3208	BNE	SOFGC	
3209	LDX	TXLVAL	
3210 SOFGC	STX	TBPNTR	
3211	CPX	TXLGDP	LAST GOOD DATA?
3212	BNE	SOFGD	
3213	LDX	#0	YES
3214	STX	TXLGDP	
3215	STAB	TXDONE	
3216 SOFGD	STAA	PIA1BD	OUTPUT CHAR #5
3217	LDX	OUTCHC	
3218	DEX		
3219	BNE	SOFH	
3220	JMP	SOFT	
3221 SOFH	STX	OUTCHC	
3222	LDAA	DATA5	FIFO READY?
3223	BPL	SOFHA	
3224	JMP	SOF S	
3225 SOFHA	LDX	TXCHCT	
3226	BNE	SOFHB	
3227	LDAA	#0FFH	GET STUFF CHAR
3228	STAA	TXEND	
3229	LDX	TXPNTR	
3230	STAA	13,X	SET PORT'S OUF G
3231	BRA	SOFHD	
3232 SOFHB	DEX		
3233	STX	TXCHCT	
3234	LDX	TBPNTR	
3235	LDAA	0,X	GET BUFF CHAR
3236	INX		
3237	CPX	TXUVAL	ADJ BUFF PNTRS
3238	BNE	SOFHC	
3239	LDX	TXLVAL	
3240 SOFHC	STX	TBPNTR	
3241	CPX	TXLGDP	LAST GOOD DATA?

3242	BNE	SOFHD	
3243	LDX	#0	YES
3244	STX	TXLGDP	
3245	STAB	TXDONE	
3246	SOFHD	STAA	PIA1BD OUTPUT CHAR #6
3247	LDX	OUTCHC	
3248	DEX		
3249	BNE	SOFI	
3250	JMP	SOFT	
3251	SOFI	STX	OUTCHC
3252	LDAA	DATA5	FIFO READY?
3253	BPL	SOFIA	
3254	JMP	SOFS	
3255	SOFIA	LDX	TXCHCT
3256	BNE	SOFIB	
3257	LDAA	#0FFH	GET STUFF CHAR
3258	STAA	TXEND	
3259	LDX	TXPNTR	
3260	STAA	13,X	SET PORT'S OUFG
3261	BRA	SOFID	
3262	SOFIB	DEX	
3263	STX	TXCHCT	
3264	LDX	TBPNTR	
3265	LDAA	0,X	GET BUFF CHAR
3266	INX		
3267	CPX	TXUVAL	ADJ BUFF PNTRS
3268	BNE	SOFIC	
3269	LDX	TXLVAL	
3270	SOFIC	STX	TBPNTR
3271	CPX	TXLGDP	LAST GOOD DATA?
3272	BNE	SOFID	
3273	LDX	#0	YES
3274	STX	TXLGDP	
3275	STAB	TXDONE	
3276	SOFID	STAA	PIA1BD OUTPUT CHAR #7
3277	LDX	OUTCHC	
3278	DEX		
3279	BNE	SOFJ	
3280	JMP	SOFT	
3281	SOFJ	STX	OUTCHC
3282	LDAA	DATA5	FIFO READY?
3283	BPL	SOFJA	
3284	JMP	SOFS	
3285	SOFJA	LDX	TXCHCT
3286	BNE	SOFJB	
3287	LDAA	#0FFH	GET STUFF CHAR
3288	STAA	TXEND	
3289	LDX	TXPNTR	
3290	STAA	13,X	SET PORT'S OUFG
3291	BRA	SOFJD	
3292	SOFJB	DEX	
3293	STX	TXCHCT	
3294	LDX	TBPNTR	
3295	LDAA	0,X	GET BUFF CHAR
3296	INX		
3297	CPX	TXUVAL	ADJ BUFF PNTRS
3298	BNE	SOFJC	

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3299      LDX      TXLVAL
3300  SOFJC  STX      TBPNTR
3301      CPX      TXLGDP    LAST GOOD DATA?
3302      BNE      SOFJD
3303      LDX      #0        YES
3304      STX      TXLGDP
3305      STAB     TXDONE
3306  SOFJD  STAA     PIA1BD   OUTPUT CHAR #8
3307      LDX      OUTCHC
3308      DEX
3309      BNE      SOFK
3310      JMP      SOFT
3311  SOFK   STX      OUTCHC
3312      LDAA     DATA5    FIFO READY?
3313      BPL      SOFKA
3314      JMP      SOFS
3315  SOFKA  LDX      TXCHCT
3316      BNE      SOFKB
3317      LDAA     #0FFH   GET STUFF CHAR
3318      STAA     TXEND
3319      LDX      TXPNTR
3320      STAA     13,X    SET PORT'S OUFG
3321      BRA      SOFKD
3322  SOFKB  DEX
3323      STX      TXCHCT
3324      LDX      TBPNTR
3325      LDAA     0,X     GET BUFF CHAR
3326      INX
3327      CPX      TXUVAL   ADJ BUFF PNTRS
3328      BNE      SOFKC
3329      LDX      TXLVAL
3330  SOFKC  STX      TBPNTR
3331      CPX      TXLGDP   LAST GOOD DATA?
3332      BNE      SOFKD
3333      LDX      #0        YES
3334      STX      TXLGDP
3335      STAB     TXDONE
3336  SOFKD  STAA     PIA1BD   OUTPUT CHAR #9
3337      LDX      OUTCHC
3338      DEX
3339      BNE      SOFL
3340      JMP      SOFT
3341  SOFL   STX      OUTCHC
3342      LDAA     DATA5    FIFO READY?
3343      BPL      SOFLA
3344      JMP      SOFS
3345  SOFLA  LDX      TXCHCT
3346      BNE      SOFLB
3347      LDAA     #0FFH   GET STUFF CHAR
3348      STAA     TXEND
3349      LDX      TXPNTR
3350      STAA     13,X    SET PORT'S OUFG
3351      BRA      SOFLD
3352  SOFLB  DEX
3353      STX      TXCHCT
3354      LDX      TBPNTR
3355      LDAA     0,X     GET BUFF CHAR

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3356	INX			
3357	CPX	TXUVAL	ADJ BUFF PNTRS	
3358	BNE	SOFLC		
3359	LDX	TXLVAL		
3360	SOFLC	STX	TBPNTR	
3361	CPX	TXLGDP	LAST GOOD DATA?	
3362	BNE	SOFLD		
3363	LDX	#0	YES	
3364	STX	TXLGDP		
3365	STAB	TXDONE		
3366	SOFLD	STAA	PIA1BD	OUTPUT CHAR #10
3367	LDX	OUTCHC		
3368	DEX			
3369	BNE	SOFM		
3370	JMP	SOFT		
3371	SOFM	STX	OUTCHC	
3372	LDAA	DATA5	FIFO READY?	
3373	BPL	SOFMA		
3374	JMP	SOFS		
3375	SOFMA	LDX	TXCHCT	
3376	BNE	SOFMB		
3377	LDAA	#0FFH	GET STUFF CHAR	
3378	STAA	TXEND		
3379	LDX	TXPNTR		
3380	STAA	13,X	SET PORT'S OUFG	
3381	BRA	SOFMD		
3382	SOFMB	DEX		
3383	STX	TXCHCT		
3384	LDX	TBPNTR		
3385	LDAA	0,X	GET BUFF CHAR	
3386	INX			
3387	CPX	TXUVAL	ADJ BUFF PNTRS	
3388	BNE	SOFMC		
3389	LDX	TXLVAL		
3390	SOFMC	STX	TBPNTR	
3391	CPX	TXLGDP	LAST GOOD DATA?	
3392	BNE	SOFMD		
3393	LDX	#0	YES	
3394	STX	TXLGDP		
3395	STAB	TXDONE		
3396	SOFMD	STAA	PIA1BD	OUTPUT CHAR #11
3397	LDX	OUTCHC		
3398	DEX			
3399	BNE	SOFN		
3400	JMP	SOFT		
3401	SOFN	STX	OUTCHC	
3402	LDAA	DATA5	FIFO READY?	
3403	BPL	SOFNA		
3404	JMP	SOFS		
3405	SOFNA	LDX	TXCHCT	
3406	BNE	SOFNB		
3407	LDAA	#0FFH	GET STUFF CHAR	
3408	STAA	TXEND		
3409	LDX	TXPNTR		
3410	STAA	13,X	SET PORT' OUFG	
3411	BRA	SOFND		
3412	SOFNB	DEX		

3413	STX	TXCHCT
3414	LDX	TBPNTR
3415	LDAA	0,X GET BUFF CHAR
3416	INX	
3417	CPX	TXUVAL AND BUFF PNTRS
3418	BNE	SOFNC
3419	LDX	TXLVAL
3420	SOFNC	STX TBPNTR
3421	CPX	TXLGDP LAST GOOD DATA?
3422	BNE	SOFND
3423	LDX	#0 YES
3424	STX	TXLGDP
3425	STAB	TXDONE
3426	SOFND	STA A PIA1BD OUTPUT CHAR #12
3427	LDX	OUTCHC
3428	DEX	
3429	BNE	SOFO
3430	JMP	SOFT
3431	SOFO	STX OUTCHC
3432	LDAA	DATA5 FIFO READY?
3433	BPL	SOFOA
3434	JMP	SOFS
3435	SOFOA	LDX TXCHCT
3436	BNE	SOFOB
3437	LDAA	#OFFH GET STUFF CHAR
3438	STA A	TXEND
3439	LDX	TXPNTR
3440	STA A	13,X SET PORT'S OUFG
3441	BRA	SOFOD
3442	SOFOB	DEX
3443	STX	TXCHCT
3444	LDX	TBPNTR
3445	LDAA	0,X GET BUFF CHAR
3446	INX	
3447	CPX	TXUVAL ADJ BUFF PNTRS
3448	BNE	SOFOC
3449	LDX	TXLVAL
3450	SOFOC	STX TBPNTR
3451	CPX	TXLGDP LAST GOOD DATA?
3452	BNE	SOFOD
3453	LDX	#0 YES
3454	STX	TXLGDP
3455	STAB	TXDONE
3456	SOFOD	STA A PIA1BD OUTPUT CHAR #13
3457	LDX	OUTCHC
3458	DEX	
3459	BNE	SOFP
3460	JMP	SOFT
3461	SOFP	STX OUTCHC
3462	LDAA	DATA5 FIFO READY?
3463	BPL	SOFPA
3464	JMP	SOFS
3465	SOFPA	LDX TXCHCT
3466	BNE	SOFPB
3467	LDAA	#OFFH GET BUFF CHAR
3468	STA A	TXEND
3469	LDX	TXPNTR

3470	STAA	13,X	SET PORT'S OUFG
3471	BRA	SOFPD	
3472 SOFPB	DEX		
3473	STX	TXCHCT	
3474	LDX	TBPNTR	
3475	LDAA	0,X	GET BUF CHAR
3476	INX		
3477	CPX	TXUVAL	ADJ BUFF PNTRS
3478	BNE	SOFPC	
3479	LDX	TXLVAL	
3480 SOFPC	STX	TBPNTR	
3481	CPX	TXLGDP	LAST GOOD DATA?
3482	BNE	SOFPD	
3483	LDX	#0	YES
3484	STX	TXLGDP	
3485	STAB	TXDONE	
3486 SOFPD	STAA	PIA1BD	OUTPUT CHAR #14
3487	LDX	OUTCHC	
3488	DEX		
3489	BNE	SOFQ	
3490	JMP	SOFT	
3491 SOFQ	STX	OUTCHC	
3492	LDAA	DATA5	FIFO READY?
3493	BPL	SOFQA	
3494	JMP	SOFS	
3495 SOFQA	LDX	TXCHCT	
3496	BNE	SOFQB	
3497	LDAA	#0FFH	GET STUFF CHAR
3498	STAA	TXEND	
3499	LDX	TXPNTR	
3500	STAA	13,X	SET PORT'S OUFG
3501	BRA	SOFQD	
3502 SOFQB	DEX		
3503	STX	TXCHCT	
3504	LDX	TBPNTR	
3505	LDAA	0,X	GET BUFF CHAR
3506	INX		
3507	CPX	TXUVAL	ADJ BUFF PNTRS
3508	BNE	SOFQC	
3509	LDX	TXLVAL	
3510 SOFQC	STX	TBPNTR	
3511	CPX	TXLGDP	LAST GOOD DATA?
3512	BNE	SOFQD	
3513	LDX	#0	YES
3514	STX	TXLGDP	
3515	STAB	TXDONE	
3516 SOFQD	STAA	PIA1BD	OUTPUT CHAR #15
3517	LDX	OUTCHC	
3518	DEX		
3519	BEQ	SOFT	
3520 SOFR	STX	OUTCHC	
3521	LDAA	DATA5	FIFO READY?
3522	BPL	SOFRA	
3523	JMP	SOFS	
3524 SOFRA	LDX	TXCHCT	
3525	BNE	SOFRB	
3526	LDAA	#0FFH	GET STUFF CHAR

3527	STAA	TXEND
3528	LDX	TXPNTR
3529	STAA	13,X SET PORT'S OUFG
3530	BRA	SOFRD
3531 SOFRB	DEX	
3532	STX	TXCHCT
3533	LDX	TBPNTR
3534	LDAA	0,X GET BUFF CHAR
3535	INX	
3536	CPX	TXUVAL ADJ BUFF PNTRS
3537	BNE	SOFRC
3538	LDX	TXLVAL
3539 SOFRC	STX	TBPNTR
3540	CPX	TXLGDP LAST GOOD DATA?
3541	BNE	SOFRD
3542	LDX	#0 YES
3543	STX	TXLGDP
3544	STAB	TXDONE
3545 SOFRD	STAA	PIA1BD OUTPUT CHAR #16
3546	LDX	OUTCHC
3547	DEX	
3548	BEQ	SOFT
3549	STX	OUTCHC
3550 SOFS	LDX	TXPNTR STORE BUFF PNTRS
3551	LDAA	TXCHCT
3552	LDAB	TXCHCT+1
3553	STAA	4,X RESTORE BUFF CHAR COUNT
3554	STAB	5,X
3555	LDAA	TBPNTR
3556	LDAB	TBPNTR+1
3557	STAA	2,X RESTORE BUFF OUTPUT PNTR
3558	STAB	3,X
3559	LDAA	TXLGDP
3560	LDAB	TXLGDP+1
3561	STAA	14,X RESTORE L.G.D. PNTR
3562	STAB	15,X
3563	RTS	
3564 SOFT	LDAA	TXEND
3565	BEQ	SOFTB
3566 SOFTA	CLRB	
3567	STAB	TXEND
3568	STAB	TXDONE
3569	STAB	TXCHCT
3570	STAB	TXCHCT+1
3571	LDAA	XMASK CLR "DATA RDY PORT-"
3572	ANDA	PA1AD
3573	STAA	PA1AD
3574	STAA	PIA1AD
3575	LDX	TXPNTR
3576	STAB	8,X CLR TX REQ FLAG
3577	STAB	13,X CLR OUFG
3578	STAB	6,X CLR EMPTY
3579	STAB	4,X CLR CHCT
3580	STAB	5,X
3581	LDAB	#3
3582	STAB	7,X SET FLBFG
3583	LDAA	MASKR TX ACK OF I/O PORT

3584	ANDA	MRFTA	AND SET FIFO'S MR
3585	LDAB	XMASK	
3586	COMB		
3587	STAB	XMASK	
3588	ORAA	XMASK	
3589	STAA	MRFTA	
3590	STAA	LATCH3	
3591	BRA	SOFU	
3592	SOFTB	LDAA	TXDONE
3593		BEQ	SOFU
3594		LDAA	XMASK TEST PORT'S TX REQ INPUT
3595		COMA	
3596		ANDA	DATA1
3597		BEQ	SOFTA
3598	SOFU	CLRA	
3599		STAA	SOEN
3600		BRA	SOFS
3601	SOFY	LDAB	#0FFH
3602		LDAA	TXEND
3603		BNE	SOFYA
3604		LDAA	TXDONE
3605		BEQ	SOFYXX
3606		LDAA	XMASK TEST PORT'S TX REQ INPUT
3607		COMA	
3608		ANDA	DATA1
3609		BEQ	SOFYXX BRANCH IF TX REQ = 0
3610		CLRA	GET HERE WITH MULTIPLE
3611		STAA	TXDONE TX REQS. PER FRAME
3612	SOFYXX	JMP	SOFC
3613	SOFYA	LDX	OUTCHC
3614		LDAA	DATA5 FIFO RDY?
3615		BPL	SOFYA1
3616		RTS	
3617	SOFYA1	STAB	PIA1BD OUTPUT FILL CHAR #1
3618		DEX	
3619		BEQ	SOFTA
3620	SOFYB	LDAA	DATA5 FIFO RDY?
3621		BPL	SOFYB1
3622		STX	OUTCHC
3623		RTS	
3624	SOFYB1	STAB	PIA1BD OUTPUT FILL CHAR #2
3625		DEX	
3626		BEQ	SOFTA
3627	SOFYC	LDAA	DATA5 FIFO RDY?
3628		BPL	SOFYC1
3629		STX	OUTCHC
3630		RTS	
3631	SOFYC1	STAB	PIA1BD OUTPUT FILL CHAR #3
3632		DEX	
3633		BNE	SOFYD
3634		JMP	SOFTA
3635	SOFYD	LDAA	DATA5 FIFO RDY?
3636		BPL	SOFYD1
3637		STX	OUTCHC
3638		RTS	
3639	SOFYD1	STAB	PIA1BD OUTPUT FILL CHAR #4
3640		DEX	

3641		BNE	SOFYE
3642		JMP	SOFTA
3643	SOFYE	LDA A	DATA5 FIFO RDY?
3644		BPL	SOFYE1
3645		STX	OUTCHC
3646		RTS	
3647	SOFYE1	STAB	PIA1BD OUTPUT FILL CHAR #5
3648		DEX	
3649		BNE	SOFYF
3650		JMP	SOFTA
3651	SOFYF	LDA A	DATA5 FIFO RDY?
3652		BPL	SOFYF1
3653		STX	OUTCHC
3654		RTS	
3655	SOFYF1	STAB	PIA1BD OUTPUT FILL CHAR #6
3656		DEX	
3657		BNE	SOFYG
3658		JMP	SOFTA
3659	SOFYG	LDA A	DATA5 FIFO RDY?
3660		BPL	SOFYG1
3661		STX	OUTCHC
3662		RTS	
3663	SOFYG1	STAB	PIA1BD OUTPUT FILL CHAR #7
3664		DEX	
3665		BNE	SOFYH
3666		JMP	SOFTA
3667	SOFYH	LDA A	DATA5 FIFO RDY?
3668		BPL	SOFYH1
3669		STX	OUTCHC
3670		RTS	
3671	SOFYH1	STAB	PIA1BD OUTPUT FILL CHAR #8
3672		DEX	
3673		BNE	SOFYI
3674		JMP	SOFTA
3675	SOFYI	LDA A	DATA5 FIFO RDY?
3676		BPL	SOFYI1
3677		STX	OUTCHC
3678		RTS	
3679	SOFYI1	STAB	PIA1BD OUTPUT FILL CHAR #9
3680		DEX	
3681		BNE	SOFYJ
3682		JMP	SOFTA
3683	SOFYJ	LDA A	DATA5 FIFO RDY?
3684		BPL	SOFYJ1
3685		STX	OUTCHC
3686		RTS	
3687	SOFYJ1	STAB	PIA1BD OUTPUT FILL CHAR #10
3688		DEX	
3689		BNE	SOFYK
3690		JMP	SOFTA
3691	SOFYK	LDA A	DATA5 FIFO RDY?
3692		BPL	SOFYK1
3693		STX	OUTCHC
3694		RTS	
3695	SOFYK1	STAB	PIA1BD OUTPUT FILL CHAR #11
3696		DEX	
3697		BNE	SOFYL

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3698      JMP    SOFTA
3699 SOFYL  LDAA   DATA5    FIFO RDY?
3700      BPL    SOFYL1
3701      STX    OUTCHC
3702      RTS
3703 SOFYL1 STAB   PIA1BD  OUTPUT FILL CHAR #12
3704      DEX
3705      BNE    SOFYM
3706      JMP    SOFTA
3707 SOFYM   LDAA   DATA5    FIFO RDY?
3708      BPL    SOFYM1
3709      STX    OUTCHC
3710      RTS
3711 SOFYM1 STAB   PIA1BD  OUTPUT FILL CHAR #13
3712      DEX
3713      BNE    SOFYN
3714      JMP    SOFTA
3715 SOFYN   LDAA   DATA5    FIFO RDY?
3716      BPL    SOFYN1
3717      STX    OUTCHC
3718      RTS
3719 SOFYN1 STAB   PIA1BD  OUTPUT FILL CHAR #14
3720      DEX
3721      BNE    SOFYO
3722      JMP    SOFTA
3723 SOFYO   LDAA   DATA5    FIFO RDY?
3724      BPL    SOFYO1
3725      STX    OUTCHC
3726      RTS
3727 SOFYO1 STAB   PIA1BD  OUTPUT FILL CHAR #15
3728      DEX
3729      BNE    SOFYP
3730      JMP    SOFTA
3731 SOFYP   LDAA   DATA5    FIFO RDY?
3732      BPL    SOFYP1
3733      STX    OUTCHC
3734      RTS
3735 SOFYP1 STAB   PIA1BD  OUTPUT FILL CHAR #16
3736      DEX
3737      BNE    SOFYQ
3738      JMP    SOFTA
3739 SOFYQ   STX    OUTCHC
3740      RTS
3741 ****
3742 *
3743 *      BEGIN SERVICING SYSTEM INPUT FIFO
3744 *
3745 *
3746 SIF    LDAA   SIEN
3747      BNE    SIFA
3748      JMP    TDMA
3749 *
3750 SIF1   LDX    INCHC   *RX SELF TEST ROUTINE*
3751      LDAB   #16
3752 SIF2   LDAA   DATA1    CHAR IN RX FIFO?
3753      BPL    SIF6
3754      LDAA   DATA2    LOAD CHAR

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3755      CMPA    #033H
3756      BEQ     SIF3      CORRECT CHARACTER?
3757      STAB    STERR
3758 SIF3  DEX
3759      BNE     SIF5
3760      CLRA
3761      STAA    SIEN
3762      STAA    SELFTR
3763      STX     INCHC
3764      LDAA    PA1AD
3765      LDAB    STERR
3766      BNE     SIF3A
3767      ANDA    #07FH    CLR DBP SELF TEST FAIL
3768      BRA     SIF4
3769 SIF3A ORAA    #080H    SET DBP SELF TEST FAIL
3770 SIF4  STAA    PA1AD
3771      STAA    PIA1AD
3772      ANDA    #080H    ADJUST SELF TEST
3773      ORAA    BITELT    FAIL BITE LITE
3774      STAA    BITELT
3775      STAA    LATCH2
3776      CLR     STERR
3777      JMP     TDMA
3778 SIF5  DECB
3779      BNE     SIF2
3780 SIF6  STX     INCHC
3781      JMP     TDMA
3782 *
3783 SIFA  LDAA    SELFTR    RX SELF TEST?
3784      BNE     SIF1
3785      LDAA    INPTRC
3786      BEQ     SIFA1A
3787      LDX     RCRXPT
3788 SIFR  LDAA    DATA1     CHAR IN INPUT FIFO?
3789      BMI     SIFRA
3790 SIFR1 STX     RCRXPT
3791      JMP     TDMA
3792 SIFRA LDAA    DATA2     LOAD & STORE FIFO CHAR
3793      STAA    0,X
3794      INX
3795      CPX     #ERCRX    BUFFER FULL?
3796      BNE     SIFR
3797      SEI
3798      LDX     #SRCRX
3799      LDAA    0,X
3800      STAA    ACIAD    LOAD ACIA WITH 1
3801      INX     R/CCOW RX CHARS.
3802      LDAA    #0BDH
3803      STAA    ACIACS
3804      STAA    TXIRFG
3805      STX     RCRXPT
3806      CLR     SIEN
3807      CLI
3808      JMP     TDMA
3809 ****
3810 *
3811 *FILL MISSING RX BURST WITH "FF" DATA

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3812 *
3813 SIFRB LDAB #16      INIT STORE COUNTER
3814 SIFRC LDAA #0FFH
3815     LDX RBPNTR
3816     STAA 0,X
3817     INX          ADJ PNTRS
3818     CPX RXUVAL
3819     BNE SIFRD
3820     LDX RXLVAL
3821 SIFRD STX RBPNTR
3822     LDX RBCHCT
3823     INX
3824     STX RBCHCT
3825     LDX INCHC    TEST FIFO CH CNT
3826     DEX
3827     BNE SIFRE
3828     CLR FILLFG
3829     JMP SIFQ
3830 SIFRE STX INCHC
3831     DECB        DEC STORE COUNTER
3832     BNE SIFRC
3833     JMP SIFP
3834 *
3835 *
3836 SIFA1A LDX RXPNTR  SETUP RCV PNTRS
3837     LDAA 8,X      TEST PORT'S TX REQ FLAG
3838     BNE SIFA1C
3839     LDAA PTONRX
3840     ANDA MASKIO   TEST IF PORT IS ON
3841     BNE SIFA1B
3842 SIFA1C CLR SIEN    *ABORT RX BURST: TX REQ*
3843     CLR FILLFG   *OR PORT IS OFF*
3844     JMP TDMA
3845 SIFA1B LDX 0,X
3846     STX RBPNTR
3847     LDX RXPNTR
3848     LDX 4,X
3849     STX RBCHCT
3850     LDAA FILLFG   FILL BURST WITH "FF"?
3851     BNE SIFRB
3852     LDAA DATA1
3853     BMI SIFA1
3854     JMP TDMA
3855 SIFA1  LDAA DATA2  LOAD & STORE CHAR #1
3856     LDX RBPNTR
3857     STAA 0,X
3858     INX          ADJ PNTRS
3859     CPX RXUVAL
3860     BNE SIFA2
3861     LDX RXLVAL
3862 SIFA2  STX RBPNTR
3863     LDX RBCHCT
3864     INX
3865     STX RBCHCT
3866     LDX INCHC    TEST FIFO CH CNT
3867     DEX
3868     BNE SIFB

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3869	JMP	SIFQ	
3870	SIFB	STX	INCHC
3871		LDAA	DATA1
3872		BMI	SIFB1
3873		JMP	SIFP
3874	SIFB1	LDAA	DATA2 LOAD & STORE FIFO CHAR #2
3875		LDX	RBPNTR
3876		STAA	0,X
3877		INX	ADJ PNTRS
3878		CPX	RXUVAL
3879		BNE	SIFB2
3880		LDX	RXLVAL
3881	SIFB2	STX	RBPNTR
3882		LDX	RBCHCT
3883		INX	
3884		STX	RBCHCT
3885		LDX	INCHC TEST FIFO CHAR COUNT
3886		DEX	
3887		BNE	SIFC
3888		JMP	SIFQ
3889	SIFC	STX	INCHC
3890		LDAA	DATA1
3891		BMI	SIFC1
3892		JMP	SIFP
3893	SIFC1	LDAA	DATA2 LOAD & STORE FIFO CHAR #3
3894		LDX	RBPNTR
3895		STAA	0,X
3896		INX	ADJ PNTRS
3897		CPX	RXUVAL
3898		BNE	SIFC2
3899		LDX	RXLVAL
3900	SIFC2	STX	RBPNTR
3901		LDX	RBCHCT
3902		INX	
3903		STX	RBCHCT
3904		LDX	INCHC TEST FIFO CHAR COUNT
3905		DEX	
3906		BNE	SIFD
3907		JMP	SIFQ
3908	SIFD	STX	INCHC
3909		LDAA	DATA1
3910		BMI	SIFD1
3911		JMP	SIFP
3912	SIFD1	LDAA	DATA2 LOAD & STORE FIFO CHAR #4
3913		LDX	RBPNTR
3914		STAA	0,X
3915		INX	ADJ PNTRS
3916		CPX	RXUVAL
3917		BNE	SIFD2
3918		LDX	RXLVAL
3919	SIFD2	STX	RBPNTR
3920		LDX	RBCHCT
3921		INX	
3922		STX	RBCHCT
3923		LDX	INCHC TEST FIFO CHAR COUNT
3924		DEX	
3925		BNE	SIFE

3926	JMP	SIFQ	
3927 SIFE	STX	INCHC	
3928	LDAA	DATA1	
3929	BMI	SIFE1	
3930	JMP	SIFP	
3931 SIFE1	LDAA	DATA2	LOAD & STORE FIFO CHAR #5
3932	LDX	RBNPTR	
3933	STAA	0,X	
3934	INX		ADJ PNTRS
3935	CPX	RXUVAL	
3936	BNE	SIFE2	
3937	LDX	RXLVAL	
3938 SIFE2	STX	RBNPTR	
3939	LDX	RBCHCT	
3940	INX		
3941	STX	RBCHCT	
3942	LDX	INCHC	TEST FIFO CHAR COUNT
3943	DEX		
3944	BNE	SIFF	
3945	JMP	SIFQ	
3946 SIFF	STX	INCHC	
3947	LDAA	DATA1	
3948	BMI	SIFF1	
3949	JMP	SIFP	
3950 SIFF1	LDAA	DATA2	LOAD & STORE FIFO CHAR #6
3951	LDX	RBNPTR	
3952	STAA	0,X	
3953	INX		ADJ PNTRS
3954	CPX	RXUVAL	
3955	BNE	SIFF2	
3956	LDX	RXLVAL	
3957 SIFF2	STX	RBNPTR	
3958	LDX	RBCHCT	
3959	INX		
3960	STX	RBCHCT	
3961	LDX	INCHC	TEST FIFO CHAR COUNT
3962	DEX		
3963	BNE	SIFG	
3964	JMP	SIFQ	
3965 SIFG	STX	INCHC	
3966	LDAA	DATA1	
3967	BMI	SIFG1	
3968	JMP	SIFP	
3969 SIFG1	LDAA	DATA2	LOAD & STORE FIFO CHAR #7
3970	LDX	RBNPTR	
3971	STAA	0,X	
3972	INX		ADJ PNTRS
3973	CPX	RXUVAL	
3974	BNE	SIFG2	
3975	LDX	RXLVAL	
3976 SIFG2	STX	RBNPTR	
3977	LDX	RBCHCT	
3978	INX		
3979	STX	RBCHCT	
3980	LDX	INCHC	TEST FIFO CHAR COUNT
3981	DEX		
3982	BNE	SIFH	

3983	JMP	SIFQ	
3984 SIFH	STX	INCHC	
3985	LDAA	DATA1	
3986	BMI	SIFH1	
3987	JMP	SIFP	
3988 SIFH1	LDAA	DATA2	LOAD & STORE FIFO CHAR #8
3989	LDX	RBNPTR	
3990	STAA	0,X	
3991	INX		ADJ PNTRS
3992	CPX	RXUVAL	
3993	BNE	SIFH2	
3994	LDX	RXLVAL	
3995 SIFH2	STX	RBNPTR	
3996	LDX	RBCHCT	
3997	INX		
3998	STX	RBCHCT	
3999	LDX	INCHC	TEST FIFO CHAR COUNT
4000	DEX		
4001	BNE	SIFI	
4002	JMP	SIFQ	
4003 SIFI	STX	INCHC	
4004	LDAA	DATA1	
4005	BMI	SIFI1	
4006	JMP	SIFP	
4007 SIFI1	LDAA	DATA2	LOAD & STORE FIFO CHAR #9
4008	LDX	RBNPTR	
4009	STAA	0,X	
4010	INX		ADJ PNTRS
4011	CPX	RXUVAL	
4012	BNE	SIFI2	
4013	LDX	RXLVAL	
4014 SIFI2	STX	RBNPTR	
4015	LDX	RBCHCT	
4016	INX		
4017	STX	RBCHCT	
4018	LDX	INCHC	TEST FIFO CHAR COUNT
4019	DEX		
4020	BNE	SIFX	
4021	JMP	SIFQ	
4022 SIFX	STX	INCHC	
4023	LDAA	DATA1	
4024	BMI	SIFX1	
4025	JMP	SIFP	
4026 SIFX1	LDAA	DATA2	LOAD & STORE FIFO CHAR #10
4027	LDX	RBNPTR	
4028	STAA	0,X	
4029	INX		ADJ PNTRS
4030	CPX	RXUVAL	
4031	BNE	SIFX2	
4032	LDX	RXLVAL	
4033 SIFX2	STX	RBNPTR	
4034	LDX	RBCHCT	
4035	INX		
4036	STX	RBCHCT	
4037	LDX	INCHC	TEST FIFO CHAR COUNT
4038	DEX		
4039	BNE	SIFJ	

4040	JMP	SIFQ	
4041 SIFJ	STX	INCHC	
4042	LDAA	DATA1	
4043	BMI	SIFJ1	
4044	JMP	SIFP	
4045 SIFJ1	LDAA	DATA2	LOAD & STORE FIFO CHAR #11
4046	LDX	RBNPTR	
4047	STAA	0,X	
4048	INX		
4049	CPX	RXUVAL	ADJ PNTRS
4050	BNE	SIFJ2	
4051	LDX	RXLVAL	
4052 SIFJ2	STX	RBNPTR	
4053	LDX	RBCHCT	
4054	INX		
4055	STX	RBCHCT	
4056	LDX	INCHC	TEST FIFO CHAR COUNT
4057	DEX		
4058	BNE	SIFK	
4059	JMP	SIFQ	
4060 SIFK	STX	INCHC	
4061	LDAA	DATA1	
4062	BMI	SIFK1	
4063	JMP	SIFP	
4064 SIFK1	LDAA	DATA2	LOAD & STORE FIFO CHAR #12
4065	LDX	RBNPTR	
4066	STAA	0,X	
4067	INX		ADJ PNTRS
4068	CPX	RXUVAL	
4069	BNE	SIFK2	
4070	LDX	RXLVAL	
4071 SIFK2	STX	RBNPTR	
4072	LDX	RBCHCT	
4073	INX		
4074	STX	RBCHCT	
4075	LDX	INCHC	TEST FIFO CHAR COUNT
4076	DEX		
4077	BNE	SIFL	
4078	JMP	SIFQ	
4079 SIFL	STX	INCHC	
4080	LDAA	DATA1	
4081	BMI	SIFL1	
4082	JMP	SIFP	
4083 SIFL1	LDAA	DATA2	LOAD & STORE FIFO CHAR #13
4084	LDX	RBNPTR	
4085	STAA	0,X	
4086	INX		ADJ PNTRS
4087	CPX	RXUVAL	
4088	BNE	SIFL2	
4089	LDX	RXLVAL	
4090 SIFL2	STX	RBNPTR	
4091	LDX	RBCHCT	
4092	INX		
4093	STX	RBCHCT	
4094	LDX	INCHC	TEST FIFO CHAR COUNT
4095	DEX		
4096	BNE	SIFM	

4097	JMP	SIFQ	
4098	SIFM	STX	INCHC
4099		LDAA	DATA1
4100		BPL	SIFP
4101	SIFM1	LDAA	DATA2 LOAD & STORE FIFO CHAR #14
4102		LDX	RBPNTR
4103		STAA	0,X
4104		INX	ADJ PNTRS
4105		CPX	RXUVAL
4106		BNE	SIFM2
4107		LDX	RXLVAL
4108	SIFM2	STX	RBPNTR
4109		LDX	RBCHCT
4110		INX	
4111		STX	RBCHCT
4112		LDX	INCHC TEST FIFO CHAR COUNT
4113		DEX	
4114		BEQ	SIFQ
4115	SIFN	STX	INCHC
4116		LDAA	DATA1
4117		BPL	SIFP
4118	SIFN1	LDAA	DATA2 LOAD & STORE FIFO CHAR #15
4119		LDX	RBPNTR
4120		STAA	0,X
4121		INX	ADJ PNTRS
4122		CPX	RXUVAL
4123		BNE	SIFN2
4124		LDX	RXLVAL
4125	SIFN2	STX	RBPNTR
4126		LDX	RBCHCT
4127		INX	
4128		STX	RBCHCT
4129		LDX	INCHC TEST FIFO CHAR COUNT
4130		DEX	
4131		BEQ	SIFQ
4132	SIFO	STX	INCHC
4133		LDAA	DATA1
4134		BPL	SIFP
4135	SIFO1	LDAA	DATA2 LOAD & STORE FIFO CHAR #16
4136		LDX	RBPNTR
4137		STAA	0,X
4138		INX	ADJ PNTRS
4139		CPX	RXUVAL
4140		BNE	SIFO2
4141		LDX	RXLVAL
4142	SIFO2	STX	RBPNTR
4143		LDX	RBCHCT
4144		INX	
4145		STX	RBCHCT
4146		LDX	INCHC TEST FIFO CHAR COUNT
4147		DEX	
4148		BEQ	SIFQ
4149		STX	INCHC
4150	SIFP	LDX	RXPNTR UPDATE PORT'S BUFF PNTRS.
4151		LDAA	RBCHCT
4152		LDAB	RBCHCT+1
4153		STAA	4,X

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4154      STAB    5,X
4155      LDAA    RBPNTR
4156      LDAB    RBPNTR+1
4157      STAA    0,X
4158      STAB    1,X
4159      JMP     TDMA
4160 SIFQ   CLRA
4161      STAA    SIEN
4162      BRA     SIFP
4163 ****
4164 *
4165 *     INTERRUPT REQUEST SERVICE ROUTINE
4166 *
4167 *
4168 IRS     LDAB    ACIACS
4169      LDAA    TXIRFG
4170      BEQ     IRSC
4171      BITB   #2      TDR EMPTY?
4172      BEQ     IRSC
4173      LDX     RCRXPT
4174 IRS A   LDAA    0,X
4175      STAA    ACIAD    OUTPUT CHAR TO ACIA
4176      INX
4177      STX     RCRXPT
4178      CPX     #ERCRX
4179      BNE     IRSB
4180      LDAA    #09DH    CLR TX IRQ ENABLE
4181      STAA    ACIACS
4182      CLR     TXIRFG
4183 IRS B   BITB   #1      RDR FULL?
4184      BNE     IRSE
4185      RTI
4186 IRS C   BITB   #1
4187      BNE     IRSE
4188 IRS D   LDAA    #1      RCCOW/CCOW BITE ERROR:
4189      STAA    IRSBIT  IRQ ERROR OR SCU FORMAT ERR
4190      RTI
4191 IRS E   BITB   #070H    ACIA RX ERRORS?
4192      BEQ     IRSF
4193      LDAA    #1
4194      STAA    IRSBIT
4195 IRS F   LDAA    ACIAD    LOAD ACIA RX CHAR
4196      LDAB    RCFG
4197      BEQ     IRSJ
4198      DECB
4199      BEQ     IRSG
4200      DECB
4201      BNE     IRSN
4202      LDX     RTXPT
4203      STAA    0,X     STORE CHAR IN RCCOW BUFFER
4204      INX
4205      STX     RTXPT
4206      CPX     #ERTXB
4207      BNE     IRSI
4208      LDAA    #1      SET FOR RCCOW DATA READY
4209      STAA    RDRDY
4210      BRA     IRSH

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4211	IRSG	LDX	CTXPT	
4212		STAA	0,X	STORE CHAR IN CCOW BUFFER
4213		INX		
4214		STX	CTXPT	
4215		CPX	#ECTXB	
4216		BNE	IRSI	
4217		LDAA	#2	SET FOR CCOW DATA RDY
4218		STAA	CDRDY	
4219	IRSH	CLR	RCFG	
4220	IRSI	RTI		
4221	IRSJ	CMPA	#0A3H	
4222		BNE	IRSL	
4223		LDX	#SCTXB	
4224		STX	CTXPT	
4225		LDAB	#1	
4226	IRSK	STAB	RCFG	
4227		RTI		
4228	IRSL	CMPA	#0A4H	
4229		BNE	IRSM	
4230		LDX	#SRTXB	
4231		STX	RTXPT	
4232		LDAB	#2	
4233		BRA	IRSK	
4234	IRSM	CMPA	#0A9H	
4235		BEQ	IRSMA	
4236		CMPA	#0ABH	WBR
4237		BEQ	IRSMA	WBR
4238		BRA	IRSD	WBR
4239	IRSMA	TAB		GET RXINHB BIT 2 FROM A9/A11 BIT 2 WBR
4240		ANDB	#02H	WBR
4241		STAB	RXINHB	WBR
4242		LDAB	#3	WBR
4243		STAB	RC3FG	
4244		BRA	IRSK	
4245	IRSN	LDAB	RC3FG	
4246		CMPB	#3	
4247		BEQ	IRSQ	
4248		CMPB	#2	
4249		BEQ	IRSO	
4250		TAB		GET RXINHB BITS 4,3 FROM BITS 7,6 WBR
4251		RORB		WBR
4252		RORB		WBR
4253		RORB		WBR
4254		RORB		WBR
4255		ANDB	#0CH	WBR
4256		ORAB	RXINHB	WBR
4257		STAB	RXINHB	SEF
4258		ANDA	#03FH	REMOVE RXINHB BITS BEFORE USING WBR
4259		STAA	BRATE2	PORt BIT RATES (3 & 4)
4260		TAB		
4261		ANDB	#7	
4262		ANDA	#038H	
4263		ASLB		
4264		ASLB		
4265		ASLB		
4266		STAB	CHRAT3	
4267		STAA	CHRAT4	

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4268      CLR     RCFG
4269      CLR     RC3FG
4270      RTI
4271 IRSO    TAB      GET RXINHB BIT 0 FROM BIT 6      WBR
4272      ROLB
4273      ROLB
4274      ROLB
4275      ANDB    #01H
4276      ORAB    RXINHB
4277      STAB    RXINHB
4278      ANDA    #0BFH      REMOVE RXINHB BIT BEFORE USING      SEF
4279      STAA    BRATE1      PORT BIT RATES (1 & 2)      WBR
4280      TAB
4281      ANDB    #080H
4282      STAB    BPS16K
4283      TAB
4284      ANDB    #7
4285      ANDA    #038H
4286      ASLB
4287      ASLB
4288      ASLB
4289      STAB    CHRAT1
4290      STAA    CHRAT2
4291 IRSP    DEC     RC3FG
4292      RTI
4293 IRSQ    STAA    PTONRX      PORT ON & RX ONLY INFO
4294      BRA    IRSP
4295 ****
4296 *
4297 * LOAD RX ELASTIC BUFFER FOR 16 KBPS
4298 *
4299 STUFF   LDX     #SBUFF1
4300      CLRB
4301 STUFA   STAA    0,X
4302      INX
4303      INCB
4304      BNE    STUFA
4305      RTS
4306 ****
4307 *
4308 INSERR BRA    INSERR      BAD INTERRUPT- CRASH
4309 *
4310 ****
4311 *
4312 * PROGRAM VERSION, ROM CHECKSUM VALUES, AND INTERRUPT VECTORS.
4313 *
4314 ****
4315      ORG     0FFF5H
4316 PGMVRS FCB     4      **PROGRAM VERSION**
4317 CKSMB  RMB     1      MSB OF CHECKSUM - BD. PROGRAMMER SUPPLIES VALUE
4318 CKSMA  RMB     1      LSB OF CHECKSUM - SEE 98-P08293T FOR DETAILS.
4319      FDB    IRS      IRQ VECTOR
4320      FDB    INSERR    SWI ERROR
4321      FDB    INSERR    NMI ERROR
4322      FDB    PWRON     RESTART VECTOR
4323 *
4324      END    PWRON

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APPENDIX E

A. DATA BUFFER PROCESSOR LABEL CROSS REFERENCE

Label Name	Defined On	Referenced On							
BITRAT	642	637	943						
BSERV	2801	2351	2385	2406	2524	2528	2566	2580	2662
		2684	2720	2740	2748	2757	2761	2765	2768
		2771	2775	2779	2783	2787	2791		
BSERVA	2806	2803							
BSERVB	2821	2807							
BSERVC	2826	2809							
BSERVD	2832								
BSERVE	2833	2831	2835						
BSERVF	2834	2829							
BSERVG	2848	2843	2845						
BSERVH	2858	2853	2855						
BSERVI	2868	2863	2865						
BSERVK	2878	2873	2875						
CKSMA	4318								
CKSMB	4317								
CLEAR	116	29	126						
CLEARA	118	120							
INIT	68	11	175						
INSERR	4308	4308							
IO1A	1128	988							
IO1A1	989	986							
IO1A2	992	990							
IO1A3	1025	1023							
IO1AA	1132	1130							
IO1B	1136	1134							
IO1BA	1144	1147							
IO1BB	1145	1143							
IO1C	1148	1137	1139						
IO1CA	1152	1141							
IO1D	1160	1149	1314						
IO1E	1164	1151							
IO1F	1168	1166							
IO1G	1200	1342							
IO1H	1210	1161							
IO1HA	1214	1212							
IO1HB	1217	1215							
IO1I	1221	1219	1284						
IO1K	1226	1224							

Label Name	Defined On	Referenced On							
IO1LF	1065	1387	1391	1395	1401	1405	1409	1413	1417
		1421	1425						
IO1LF1	1071	1068							
IO1LFA	1078	1073							
IO1LFB	1081	1075	1077	1079					
IO1LFC	1095	1085	1089						
IO1LFD	1102	1098							
IO1LS	1030	1221	1226	1231	1236	1244	1249	1254	1259
		1264	1269	1274					
IO1LSA	1053	1048							
IO1LSB	1056	1050	1052	1054					
IO1LSX	1047	1037							
IO1M	1231	1229							
IO1N10	1274	1272							
IO1N2	1236	1234							
IO1N3	1240	1238							
IO1N4	1244	1242							
IO1N5	1249	1247							
IO1N6	1254	1252							
IO1N7	1259	1257							
IO1N8	1264	1262							
IO1N9	1269	1267							
IO1O	1276	1216							
IO1P	1279								
IO1PT	984	712	729	739	778	816	854	927	932
		976							
IO1XP	1285	1220	1225	1230	1235	1239	1243	1248	1253
		1258	1263	1268	1273	1275	1278		
IO1XQ	1291	1286							
IO1Y	1292	1131	1135						
IO1YA	1314	1303	1316						
IO1YA1	1318	1213							
IO1YB	1315	1293							
IO1YC	1330								
IO1YC1	1338	1376	1384						
IO1YD	1343	1144	1317						
IO1YE	1350	1348							
IO1YE0	1369	1363	1373						
IO1YE1	1370	1101	1379						
IO1YF	1378	1344							
IO1YFA	1385	1382							
IO1YG	1387								
IO1YH	1391								
IO1YI	1395								
IO1YJ	1398								

Label Name	Defined On	Referenced On							
IO1YK	1401								
IO1YL	1405								
IO1YM	1409								
IO1YN	1413								
IO1YO	1417								
IO1YP	1421								
IO1YQ	1425								
IO2A	1574	1434							
IO2A1	1435	1432							
IO2A2	1438	1436							
IO2A3	1471	1469							
IO2AA	1578	1576							
IO2B	1582	1580							
IO2BA	1590	1593							
IO2BB	1591	1589							
IO2C	1594	1583	1585						
IO2CA	1598	1587							
IO2D	1606	1595	1771						
IO2DA	1609	1607							
IO2E	1611	1597							
IO2F	1615	1613							
IO2FA	1639	1634							
IO2FB	1642	1638							
IO2G	1653	1799							
IO2GA	1657	1654							
IO2GB	1658	1656							
IO2H	1667	1608							
IO2HA	1671	1669							
IO2HB	1674	1672							
IO2I	1678	1676	1741						
IO2K	1683	1681							
IO2LF	1511	1844	1848	1852	1858	1862	1866	1870	1874
		1878	1882						
IO2LF1	1517	1514							
IO2LFA	1524	1519							
IO2LFB	1527	1521	1523	1525					
IO2LFC	1541	1531	1535						
IO2LFD	1548	1544							
IO2LS	1476	1678	1683	1688	1693	1701	1706	1711	1716
		1721	1726	1731					
IO2LSA	1499	1494							
IO2LSB	1502	1496	1498	1500					
IO2LSX	1493	1483							
IO2M	1688	1686							
IO2N10	1731	1729							
IO2N2	1693	1691							

Label Name	Defined On	Referenced On							
IO2N3	1697	1695							
IO2N4	1701	1699							
IO2N5	1706	1704							
IO2N6	1711	1709							
IO2N7	1716	1714							
IO2N8	1721	1719							
IO2N9	1726	1724							
IO2O	1733	1673							
IO2P	1736								
IO2PT	1430	991	1025	1046	1163	1167	1199	1209	1291
		1313	1349	1369	1377	1386	1390	1394	1397
		1400	1404	1408	1412	1416	1420	1424	
IO2XP	1742	1677	1682	1687	1692	1696	1700	1705	1710
		1715	1720	1725	1730	1732	1735		
IO2XQ	1748	1743							
IO2Y	1749	1577 1581							
IO2YA	1771	1760 1773							
IO2YA1	1775	1670							
IO2YB	1772	1750							
IO2YC	1787								
IO2YC1	1795	1833 1841							
IO2YD	1800	1590 1774							
IO2YE	1807	1805							
IO2YE0	1826	1820 1830							
IO2YE1	1827	1547 1836							
IO2YF	1835	1801							
IO2YFA	1842	1839							
IO2YG	1844								
IO2YH	1848								
IO2YI	1852								
IO2YJ	1855								
IO2YK	1858								
IO2YL	1862								
IO2YM	1866								
IO2YN	1870								
IO2YO	1874								
IO2YP	1878								
IO2YQ	1882								
IO3A	2031	1891							
IO3A1	1892	1889							
IO3A2	1895	1893							
IO3A3	1928	1926							
IO3AA	2035	2033							
IO3B	2039	2037							
IO3BA	2047	2050							
IO3BB	2048	2046							

Label Name	Defined On	Referenced On							
IO3C	2051	2040	2042						
IO3CA	2055	2044							
IO3D	2063	2052	2228						
IO3DA	2066	2064							
IO3E	2068	2054							
IO3F	2072	2070							
IO3FA	2096	2091							
IO3FB	2099	2095							
IO3G	2110	2256							
IO3GA	2114	2111							
IO3GB	2115	2113							
IO3H	2124	2065							
IO3HA	2128	2126							
IO3HB	2131	2129							
IO3I	2135	2133	2198						
IO3K	2140	2138							
IO3LF	1968	2301	2305	2309	2315	2319	2323	2327	2331
		2335	2339						
IO3LF1	1974	1971							
IO3LFA	1981	1976							
IO3LFB	1984	1978	1980	1982					
IO3LFC	1998	1988	1992						
IO3LFD	2005	2001							
IO3LS	1933	2135	2140	2145	2150	2158	2163	2168	2173
		2178	2183	2188					
IO3LSA	1956	1951							
IO3LSB	1959	1953	1955	1957					
IO3LSX	1950	1940							
IO3M	2145	2143							
IO3N10	2188	2186							
IO3N2	2150	2148							
IO3N3	2154	2152							
IO3N4	2158	2156							
IO3N5	2163	2161							
IO3N6	2168	2166							
IO3N7	2173	2171							
IO3N8	2178	2176							
IO3N9	2183	2181							
IO3O	2190	2130							
IO3P	2193								
IO3PT	1887	1437	1471	1492	1610	1614	1652	1666	1748
		1770	1806	1826	1834	1843	1847	1851	1854
		1857	1861	1865	1869	1873	1877	1881	
IO3XP	2199	2134	2139	2144	2149	2153	2157	2162	2167
		2172	2177	2182	2187	2189	2192		
IO3XQ	2205	2200							

Label Name	Defined On	Referenced On	
IO3Y	2206	2034	2038
IO3YA	2228	2217	2230
IO3YA1	2232	2127	
IO3YB	2229	2207	
IO3YC	2244		
IO3YC1	2252	2290	2298
IO3YD	2257	2047	2231
IO3YE	2264	2262	
IO3YE0	2283	2277	2287
IO3YE1	2284	2004	2293
IO3YF	2292	2258	
IO3YFA	2299	2296	
IO3YG	2301		
IO3YH	2305		
IO3YI	2309		
IO3YJ	2312		
IO3YK	2315		
IO3YL	2319		
IO3YM	2323		
IO3YN	2327		
IO3YO	2331		
IO3YP	2335		
IO3YQ	2339		
IO4A	2488	2348	
IO4A1	2349	2346	
IO4A2	2352	2350	
IO4A3	2385	2383	
IO4AA	2492	2490	
IO4B	2496	2494	
IO4BA	2504	2507	
IO4BB	2505	2503	
IO4C	2508	2497	2499
IO4CA	2512	2501	
IO4D	2520	2509	2685
IO4DA	2523	2521	
IO4E	2525	2511	
IO4F	2529	2527	
IO4FA	2553	2548	
IO4FB	2556	2552	
IO4G	2567	2713	
IO4GA	2571	2568	
IO4GB	2572	2570	
IO4H	2581	2522	
IO4HA	2585	2583	
IO4HB	2588	2586	
IO4I	2592	2590	2655

Label Name	Defined On	Referenced On								
IO4K	2597	2595								
IO4LF	2425	2758 2762 2766 2772 2776 2780 2784 2788 2792 2795								
IO4LF1	2431	2428								
IO4LFA	2438	2433								
IO4LFB	2441	2435 2437 2439								
IO4LFC	2455	2445 2449								
IO4LFD	2462	2458								
IO4LS	2390	2592 2597 2602 2607 2615 2620 2625 2630 2635 2640 2645								
IO4LSA	2413	2408								
IO4LSB	2416	2410 2412 2414								
IO4LSX	2407	2397								
IO4M	2602	2600								
IO4N10	2645	2643								
IO4N2	2607	2605								
IO4N3	2611	2609								
IO4N4	2615	2613								
IO4N5	2620	2618								
IO4N6	2625	2623								
IO4N7	2630	2628								
IO4N8	2635	2633								
IO4N9	2640	2638								
IO4O	2647	2587								
IO4P	2650									
IO4PT	2344	1894 1928 1949 2067 2071 2109 2123 2205 2227 2263 2283 2291 2300 2304 2308 2311 2314 2318 2322 2326 2330 2334 2338								
IO4XP	2656	2591 2596 2601 2606 2610 2614 2619 2624 2629 2634 2639 2644 2646 2649								
IO4XQ	2662	2657								
IO4Y	2663	2491 2495								
IO4YA	2685	2674 2687								
IO4YA1	2689	2584								
IO4YB	2686	2664								
IO4YC	2701									
IO4YC1	2709	2747 2755								
IO4YD	2714	2504 2688								
IO4YE	2721	2719								
IO4YE0	2740	2734 2744								
IO4YE1	2741	2461 2750								
IO4YF	2749	2715								
IO4YFA	2756	2753								
IO4YG	2758									
IO4YH	2762									
IO4YI	2766									

Label Name	Defined On	Referenced On						
IO4YJ	2769							
IO4YK	2772							
IO4YL	2776							
IO4YM	2780							
IO4YN	2784							
IO4YO	2788							
IO4YP	2792							
IO4YQ	2795							
IRS	4168							
IRSA	4174							
IRSB	4183	4179						
IRSC	4186	4170	4172					
IRSD	4188	4238						
IRSE	4191	4184	4187					
IRSF	4195	4192						
IRSG	4211	4199						
IRSH	4219	4210						
IRSI	4220	4207	4216					
IRSJ	4221	4197						
IRSK	4226	4233	4244					
IRSL	4228	4222						
IRSM	4234	4229						
IRSMA	4239	4235	4237					
IRSN	4245	4201						
IRSO	4271	4249						
IRSP	4291	4294						
IRSQ	4293	4247						
LD1	1107	1360	1361	1364	1365	1366	1367	1368
LD2	1553	1817	1818	1821	1822	1823	1824	1825
LD3	2010	2274	2275	2278	2279	2280	2281	2282
LD4	2467	2731	2732	2735	2736	2737	2738	2739
PGMVRS	4316							
PWRON	6							
PWRON1	58	30						
RAMERR	31	19	34					
RAMT	16	27						
RAMTST	17	22						
RBI	195	186	900					
RBI1C	225	222						
RBI1CA	228	226						
RBI1D	232	230						
RBI1DA	241	237						
RBI1E	242	234						
RBI1EA	252	247						
RBI1G	264	245						

Label Name	Defined On	Referenced On
RBI1GA	271	
RBI1GB	284	278
RBI1H	293	266 283
RBI1H1	294	263
RBI1HA	303	297
RBI1HB	307	302
RBI2B	313	223
RBI2C	316	314
RBI2CA	319	317
RBI2D	323	321
RBI2DA	332	328
RBI2E	333	325
RBI2EA	343	338
RBI2G	355	336
RBI2GA	362	
RBI2GB	377	369
RBI2H	386	357 376
RBI2H1	387	354
RBI2HA	396	390
RBI2HB	400	395
RBI3B	406	315
RBI3C	409	407
RBI3CA	412	410
RBI3D	416	414
RBI3DA	425	421
RBI3E	426	418
RBI3EA	436	431
RBI3G	448	429
RBI3GA	455	
RBI3GB	470	462
RBI3H	479	450 469
RBI3H1	480	447
RBI3HA	489	483
RBI3HB	493	488
RBI4B	499	408
RBI4C	502	500
RBI4CA	505	503
RBI4D	509	507
RBI4DA	518	514
RBI4E	519	511
RBI4EA	529	524
RBI4G	541	522
RBI4GA	548	
RBI4GB	563	555
RBI4H	572	543 562

Label Name	Defined On	Referenced On			
RBI4H1	573	540			
RBI4HA	582	576			
RBI4HB	586	581			
RBIA	198	196			
RBIB	210	199			
RBIBA	217	213			
RBIJ	594	501			
RBIJA	600	595			
RBIK	610	602			
RBIKA	616	634			
RBIL	619	614			
RBIM	625	636			
RBIN	631	612			
RBIO	635	632			
RBIS	637	311	404	497	590
RBISA	651	647			
RBISB	656	652			
RBISC	661	657			
RBISD	666	662			
RBISE	671	667			
RBISF	674	643			
RBIT	683	599	638		
RBIU	677	645			
ROMERR	53	48	50	56	
ROMTSA	41	46			
ROMTST	38	28			
SERVF1	2840	2847			
SERVF2	2844	2841			
SERVF3	2846	2839			
SERVG1	2850	2857			
SERVG2	2854	2851			
SERVG3	2856	2849			
SERVH1	2860	2867			
SERVH2	2864	2861			
SERVH3	2866	2859			
SERVI1	2870	2877			
SERVI2	2874	2871			
SERVI3	2876	2869			
SETUP	126				
SETUP1	127	58	188		
SETUP3	152	141			
SIF	3746	2886			
SIF1	3750	3784			
SIF2	3752	3779			
SIF3	3758	3756			

Label Name	Defined On	Referenced On
SIF3A	3769	3766
SIF4	3770	3768
SIF5	3778	3759
SIF6	3780	3753
SIFA	3783	3747
SIFA1	3855	3853
SIFA1A	3836	3786
SIFA1B	3845	3841
SIFA1C	3842	3838
SIFA2	3862	3860
SIFB	3870	3868
SIFB1	3874	3872
SIFB2	3881	3879
SIFC	3889	3887
SIFC1	3893	3891
SIFC2	3900	3898
SIFD	3908	3906
SIFD1	3912	3910
SIFD2	3919	3917
SIFE	3927	3925
SIFE1	3931	3929
SIFE2	3938	3936
SIFF	3946	3944
SIFF1	3950	3948
SIFF2	3957	3955
SIFG	3965	3963
SIFG1	3969	3967
SIFG2	3976	3974
SIFH	3984	3982
SIFH1	3988	3986
SIFH2	3995	3993
SIFI	4003	4001
SIFI1	4007	4005
SIFI2	4014	4012
SIFJ	4041	4039
SIFJ1	4045	4043
SIFJ2	4052	4050
SIFK	4060	4058
SIFK1	4064	4062
SIFK2	4071	4069
SIFL	4079	4077
SIFL1	4083	4081
SIFL2	4090	4088
SIFM	4098	4096
SIFM1	4101	

Label Name	Defined On	Referenced On																
SIFM2	4108	4106																
SIFN	4115																	
SIFN1	4118																	
SIFN2	4125	4123																
SIFO	4132																	
SIFO1	4135																	
SIFO2	4142	4140																
SIFP	4150	3833	3873	3892	3911	3930	3949	3968	3987									
		4006	4025	4044	4063	4082	4100	4117	4134									
		4162																
SIFQ	4160	3829	3869	3888	3907	3926	3945	3964	3983									
		4002	4021	4040	4059	4078	4097	4114	4131									
		4148																
SIFR	3788	3796																
SIFR1	3790																	
SIFRA	3792	3789																
SIFRB	3813	3851																
SIFRC	3814	3832																
SIFRD	3821	3819																
SIFRE	3830	3827																
SIFX	4022	4020																
SIFX1	4026	4024																
SIFX2	4033	4031																
SOF	2883	2833																
SOF1	2886	2884																
SOF2	2888	2907																
SOF3	2890	2902																
SOF4	2901	2895																
SOF5	2903	2891																
SOFA	2906	2885																
SOFAA	2914	979	2911															
SOFB	2925	2923																
SOFB1	3048	3045																
SOFB2	3053	3050																
SOFB3	3057	3054																
SOFB4	3062	3059																
SOFB5	3066	3063																
SOFB6	3070	3068																
SOFBA	2931	2928																
SOFBB	2936	2933																
SOFBC	2940	2937																
SOFBD	2945	2942																
SOFBE	2949	2946																
SOFBF	2954	2951																
SOFBG	2958	2955																

Label Name	Defined On	Referenced On
SOFBH	2963	2960
SOFBI	2967	2964
SOFBJ	2972	2969
SOFBK	2976	2973
SOFBL	2981	2978
SOFBM	2985	2982
SOFBN	2990	2987
SOFBO	2994	2991
SOFBP	2999	2996
SOFBQ	3003	3000
SOFBR	3008	3005
SOFBS	3012	3009
SOFBT	3017	3014
SOFBU	3021	3018
SOFBV	3026	3023
SOFBW	3030	3027
SOFBX	3035	3032
SOFBY	3039	3036
SOFBZ	3044	3041
SOFCA	3075	3073
SOFCB	3082	3076
SOFCC	3090	3088
SOFCD	3096	3081 3092
SOFD	3101	3099
SOFDA	3105	3103
SOFDB	3112	3106
SOFDC	3120	3118
SOFDD	3126	3111 3122
SOFE	3131	3129
SOFEA	3135	3133
SOFEB	3142	3136
SOFEC	3150	3148
SOFED	3156	3141 3152
SOFF	3161	3159
SOFFA	3165	3163
SOFFB	3172	3166
SOFFC	3180	3178
SOFFD	3186	3171 3182
SOFG	3191	3189
SOFGA	3195	3193
SOFGB	3202	3196
SOFGC	3210	3208
SOFGD	3216	3201 3212
SOFH	3221	3219

Label Name	Defined On	Referenced On
SOFHA	3225	3223
SOFHB	3232	3226
SOFHC	3240	3238
SOFHD	3246	3231 3242
SOFI	3251	3249
SOFIA	3255	3253
SOFIB	3262	3256
SOFIC	3270	3268
SOFID	3276	3261 3272
SOFJ	3281	3279
SOFJA	3285	3283
SOFJB	3292	3286
SOFJC	3300	3298
SOFJD	3306	3291 3302
SOFK	3311	3309
SOKFA	3315	3313
SOKKB	3322	3316
SOKKC	3330	3328
SOKKD	3336	3321 3332
SOKL	3341	3339
SOKLA	3345	3343
SOKLB	3352	3346
SOKLC	3360	3358
SOKLD	3366	3351 3362
SOKM	3371	3369
SOKMA	3375	3373
SOKMB	3382	3376
SOKMC	3390	3388
SOKMD	3396	3381 3392
SOKN	3401	3399
SOKNA	3405	3403
SOKNB	3412	3406
SOKNC	3420	3418
SOKND	3426	3411 3422
SOKO	3431	3429
SOKOA	3435	3433
SOKOB	3442	3436
SOKOC	3450	3448
SOKOD	3456	3441 3452
SOKP	3461	3459
SOKPA	3465	3463
SOKPB	3472	3466
SOKPC	3480	3478
SOKPD	3486	3471 3482
SOKQ	3491	3489

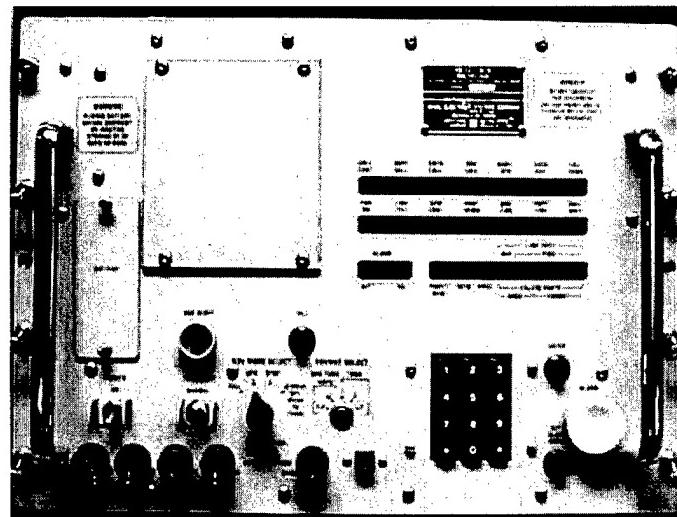
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SOFQA	3495	3493								
SOFQB	3502	3496								
SOFQC	3510	3508								
SOFQD	3516	3501 3512								
SOFR	3520									
SOFRA	3524	3522								
SOFRB	3531	3525								
SOFRC	3539	3537								
SOFRD	3545	3530 3541								
SOFS	3550	3074	3104	3134	3164	3194	3224	3254	3284	
		3314	3344	3374	3404	3434	3464	3494	3523	
		3600								
SOFT	3564	3100	3130	3160	3190	3220	3250	3280	3310	
		3340	3370	3400	3430	3460	3490	3519	3548	
SOFTA	3566	3597	3619	3626	3634	3642	3650	3658	3666	
		3674	3682	3690	3698	3706	3714	3722	3730	
		3738								
SOFTB	3592	3565								
SOFU	3598	3591	3593							
SOFY	3601	2924								
SOFYA	3613	3603								
SOFYA1	3617	3615								
SOFYB	3620									
SOFYB1	3624	3621								
SOFYC	3627									
SOFYC1	3631	3628								
SOFYD	3635	3633								
SOFYD1	3639	3636								
SOFYE	3643	3641								
SOFYE1	3647	3644								
SOFYF	3651	3649								
SOFYF1	3655	3652								
SOFYG	3659	3657								
SOFYG1	3663	3660								
SOFYH	3667	3665								
SOFYH1	3671	3668								
SOFYI	3675	3673								
SOFYI1	3679	3676								
SOFYJ	3683	3681								
SOFYJ1	3687	3684								
SOFYK	3691	3689								
SOFYK1	3695	3692								
SOFYL	3699	3697								
SOFYL1	3703	3700								
SOFYM	3707	3705								

Label Name	Defined On	Referenced On												
SOFYM1	3711	3708												
SOFYN	3715	3713												
SOFYN1	3719	3716												
SOFYO	3723	3721												
SOFYO1	3727	3724												
SOFYP	3731	3729												
SOFYP1	3735	3732												
SOFYQ	3739	3737												
SOFYXX	3612	3605	3609											
STUFA	4301	4304												
STUFF	4299	279	370	463	556									
TBI	692	197	227	231	251	318	322	342						
		415	435	504	508	528	617	630						
TBI1	698	693												
TBI1BA	741	738												
TBI1E	748	742												
TBI1EA	752	747												
TBI1F	768	766												
TBI2	703	697												
TBI2B	773	735												
TBI2BA	779	777												
TBI2E	786	780												
TBI2EA	790	785												
TBI2F	806	804												
TBI3	705	699												
TBI3B	811	774												
TBI3BA	817	815												
TBI3E	824	818												
TBI3EA	828	823												
TBI3F	844	842												
TBI4	710	706												
TBI4B	849	812												
TBI4BA	855	853												
TBI4E	862	856												
TBI4EA	866	861												
TBI4F	882	880												
TBIA	713	711												
TBIB	721	714												
TBIBA	730	728												
TBIG	887	730	850											
TBIG1	897	899												
TBIGA	901	888												
TBIGB	908	910												
TBIGC	912	905												
TBIH	914	918												

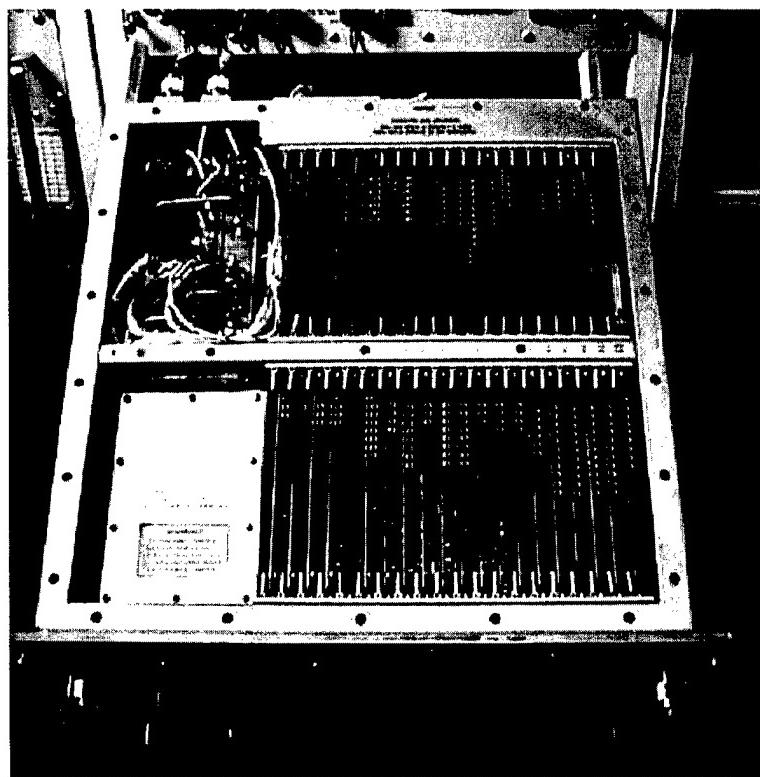
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TBIHA	921	942						
TBIHB	925	911						
TBIHC	928	926						
TBIJ	933	902						
TBIK	935	939						
TBIN	943	771	809	847	885			
TBIO	944							
TBIQ	949							
TBIQ1	952							
TBIR	962	958						
TBIRA	964	959	961					
TBIRB	977	970						
TBIS	979	951	963					
TDMA	156	64	172	183	3748	3777	3781	3791
		3844	3854	4159				3808
TDMA1	185	159						
TDMAA	170	167						
TDMAB	171	169						
TDMAI	174	161						
TIBA	731	725						
TSTROM	28	24						

APPENDIX F

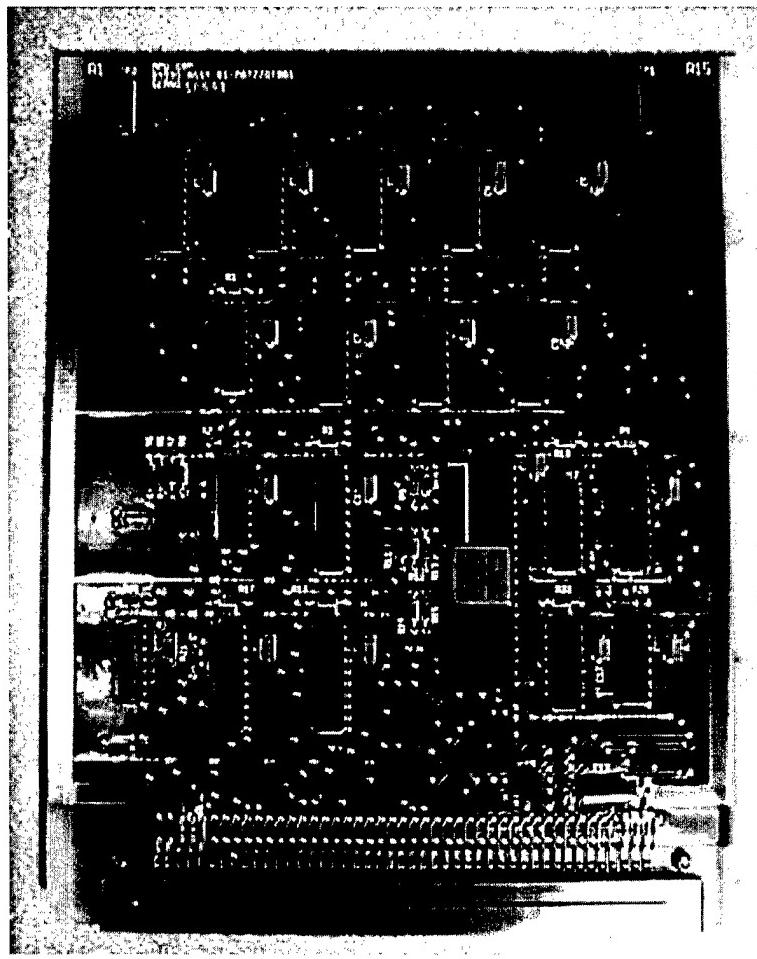
A. PHOTOS



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